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VOLUME 7, No 4 APRIL 1955

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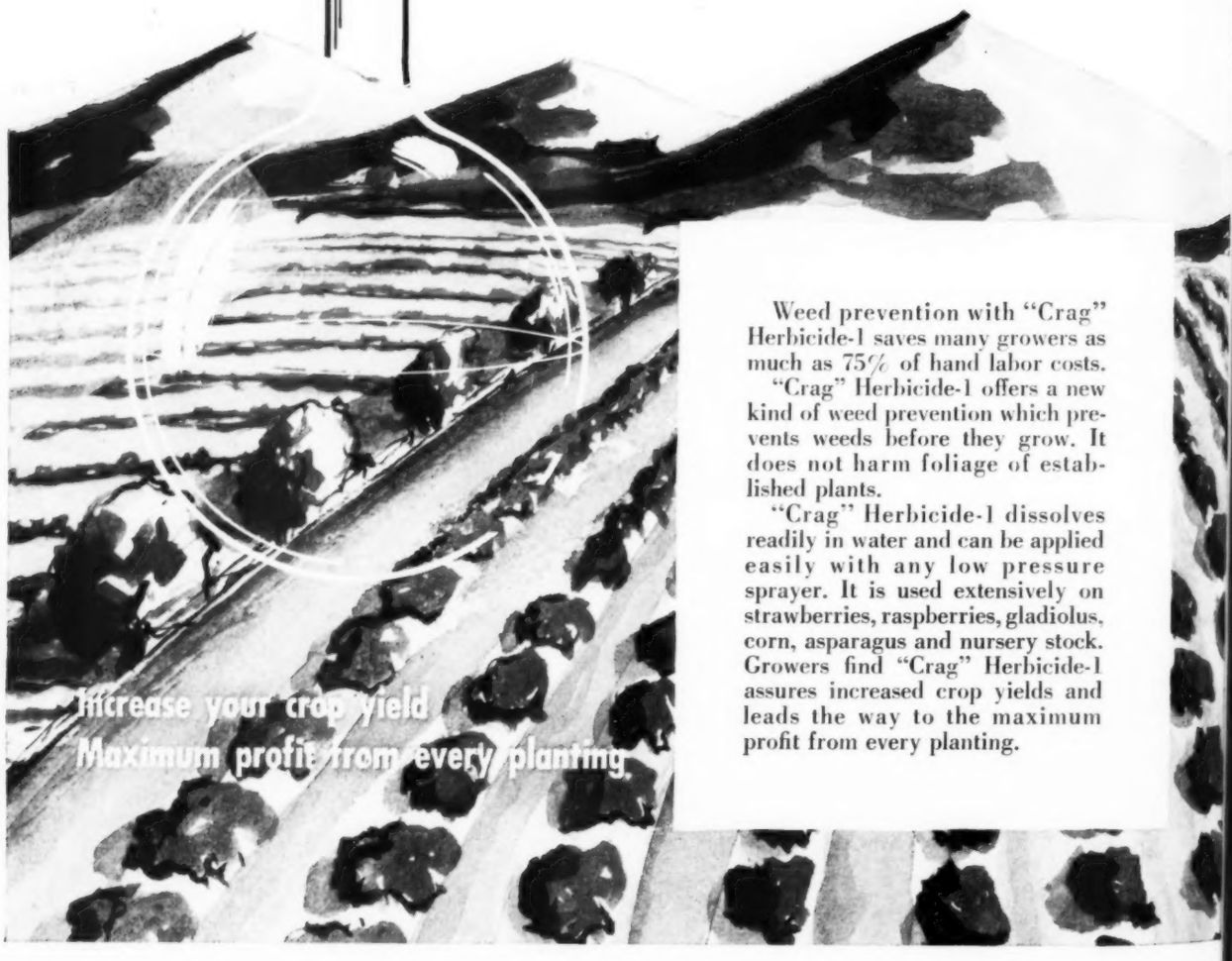

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WORLD CROPS

Vol. 7. No. 4 APRIL 1955

CONTENTS

EDITORIAL COMMENT:
Agriculture in the Netherlands; Problem for Chemurgy; Myxomatosis in Britain; Feathering the Bed; Indian Jute Inquiry; Cotton and Hormones; Acres under Glass; Acres under Water; Irrigation in India 133

The Agricultural Revolution in Turkey: 1—*P. A. Oram*, M.A., DIP.AGRIC. (CANTAB.) *and D. K. Jones*, M.SC. (WALES) 137

The Improvement of the West African Natural Palm Groves—*C. W. S. Hartley*, M.A., DIP.AG.SCI. (CANTAB.), A.I.C.T.A. 143

New Trends in Lucerne Seed Production in the United States—*Dr. C. de Fellner* 149

Endrin—*L. W. Leyland Cole*, M.SC., B.SC. (AGRIC.), F.R.I.C. 154

Agronomic Value and Production of TVA Fertilisers—*D. W. Thorne and L. F. Seatz* 159

Sugar Production in Indonesia—*John Grindrod*, B.A. (COM.) 163

International Standardisation of Farm Tractor and Machinery Details 165

Hybrid Maize in Egypt 166

Indian Paddy Machinery in Ceylon 168

New Books 169

Farm Machinery 171

World Crop Reports 173

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Editorial Comment

Agriculture in the Netherlands

WITH a rapidly increasing population and the need still to conserve foreign exchange as much as possible, agriculture assumes an important place in the Dutch national economy and everything possible is being done to make her 2.5 million hectares of cultivated land feed more than 10 million inhabitants. Self-sufficiency means that four people have to be fed from 2½ acres.

To boost the yield per acre from her arable land, which for most crops is claimed to be better than those attained in any other part of the world, liberal dressings of artificial fertilisers are applied. Per unit of surface, the quantities of these used in the Netherlands are also claimed to be higher than in any other country of the globe. An average of 50 kg. per hectare of N, P_2O_5 and K_2O and 150 kg. of CaO is applied throughout the country. Grassland is also dressed with ever-increasing quantities of fertilisers, the use of N, at 60 kg. per hectare, being twice the amount applied before the war. Such yields as 25 tons per hectare for potatoes, 40 tons per hectare for sugar beet and 3 to 5 tons for wheat are claimed to result from this treatment.

Yields of the grasslands, too, have shown a continuous increase since the war and today equal almost 3 metric tons of starch equivalent per hectare compared with 2½ metric tons before the war. This increase is due not only to double the pre-war quantities of nitrogenous fertiliser applied, but also to improved systems of grazing. In this connection some 70,000 electric fences are now used for the intensive close-folding of cattle. Before the war there were none. Better methods are also used now for conserving hay, making silage and for the artificial drying of grass. The use of tripods in hay making has increased considerably. The production of grassland feeding stuffs is, indeed, outstanding and amounts to 40% of the total feed consumed by livestock. More than half the total cultivated area is under grass, that part of the area under leys showing a steady increase.

In growing fodder crops much attention is paid to fodder beet, stock-feed potatoes, pulses and maize. The area under maize is today three times as large as before the war.

With the shortage of arable land, of which 2,500 hectares per annum (equivalent during the last eight years to the area of the reclaimed Wieringermeer in the enclosed Zuider Zee) has had to be sacrificed for building sites, development of industries and roads, much attention is being paid to land improvement, the reclaiming of new land and the consolidation of farms. Approximately one-third of the cultivated area is in need of re-allocation.

Only 7% of the total area of the country is waste land and not more than 50,000 hectares of this is good enough to be reclaimed. By the reclamation of heaths and bogs, the drainage of parts of the former Zuider Zee and enclosure within the coast line, a total of 10% could be added to this area. Of the five projected Zuider Zee polders, two have been completed during the past 20 years, covering a total area of 68,000 hectares.

Problem for chemurgy

IN the whole range of what is known as chemurgy no problems seem bigger than those of forestry wastes. Recent investigations in Canada at the Ontario Research Foundation have shown that huge quantities of essential oil could be obtained simply by steam distilling the coniferous foliage annually discarded by the forestry industry. The needles of spruce and balsam contain about 1% of these pleasantly odorous oils. The annual spruce cut in Ontario alone, if the wasted foliage was all processed, could produce 5 million lb. of the oils. But this massive potentiality creates its own problem. There is a market for this type of oil, principally for perfuming purposes—but 5 million lb. a year would considerably exceed the total demand of this market. If the large-scale application of this by-product process is to be successful, new uses for the oils must be found. It is not wholly dissimilar a problem to that of turning lignin, an even larger forestry waste, into synthetic vanilla—the process is sound, but a mere fraction of the waste can produce enough to satisfy the world market.

Chemists should be able to find a solution. These coniferous wood oils are not merely aromatic; they consist of mixtures of chemical substances, many of them belonging to the terpene family. In these days of industrial organic chemistry, terpenes should surely be useful as starting materials for synthetic processes. That they have not been given much consideration as such in the past is due to the fact that an abundant and cheap supply has not been thought possible. Industrially the chemical possibilities of terpenes have been neglected. Here, then, is a chance for some new and perhaps well-rewarding venture. If chemists can suggest ways of converting terpenes into world-needed chemicals, Canada's forestry wastes could produce the terpenes.

Myxomatosis in Britain

READERS of Dr. Andrewes' article on myxomatosis in Britain which appeared in our December 1954 issue will be interested in the recently published second report of the Myxomatosis Advisory Committee. It is, in effect, a progress report on the spread of the disease during 1954. When the first report of the committee was made in March last there had been 12 isolated outbreaks of myxomatosis in wild rabbits in four counties in South-East England but by the end of December 1954 the disease had spread extensively all over Wales and the southern half of England, while scattered and widely distributed outbreaks had occurred over the rest of England and Scotland. The committee has no doubt that the disease will survive the winter and that there is no way of preventing it from spreading widely during the coming spring and summer.

Mosquitoes appear to have played little or no part as carriers of the disease during 1954; the chief insect responsible for the spread of the disease has been the rabbit flea. Birds and other predators and scavengers may have carried the disease longer distances by acting as temporary hosts of infected fleas.

The virus has been extremely virulent in Great Britain during 1954 and the report suggests that less than 1% of affected rabbits have survived; but experience in Australia (see our last issue page 118) and elsewhere suggests that the number of immune survivors may increase in future years. This renders it all the more important that the present opportunity should be taken to destroy survivors. The committee acknowledges the steps that are being taken by County Agricultural Executive Committees, but recommends that Ministers should consider what further assistance could be given to occupiers in eliminating survivors. Since the autumn of 1954 County Agricultural Executive Committees, in collaboration with farmers, landowners, farm workers and those engaged in forestry, have been planning measures to destroy survivors in areas where the disease has taken a substantial toll. These mopping-up operations, which are being carried out on a parish or district basis with a prominent local farmer or landowner as organiser, are rapidly gaining momentum. Time will show how successful these measures have been and it will then be possible to consider whether and in what way the steps being taken need to be augmented. In England and Wales the Land Pests Advisory Committee, and in Scotland the Rabbit Clearance Advisory Committee, are watching this problem closely and will give further advice to Ministers.

Where rabbits have been largely eliminated there has been a marked improvement in grass and other crops but the report draws attention to a problem that may arise on unploughable land, such as steep chalk downland pastures, where the only grazing animal in recent times has been the rabbit. This aspect is being further examined by the Ministry and consideration is being given to the need to re-stock such areas with sheep or cattle. The report also refers to the steps taken to protect domestic rabbits; the effect of the disease on trapping and sale of rabbits; the possible effect of predators; and developments in Australia and Europe.

Feathering the bed

IT is a truism that British farmers always grumble; certainly most of the views expressed at recent farming conferences have suggested that the farmer is tottering to Carey Street and having his pockets picked on the way by those branches of industry that supply farms with their essential needs. We suspect that the farmers who are still making home food production pay handsomely are silent listeners on most of these occasions; and we suspect, too, that there are many of them. The plain truth is perhaps a little hard. Successful farming is no longer a primary exercise in producing food from the soil. When any food we could get from British soil saved precious shipping space in war-time or desperately scarce currency in the earlier post-war years, the method of production mattered very little. Today, production must be on a sound technical basis and on a sound economic basis; often enough, the achievement of the one is *ipso facto* the achievement of the other. The right kind of production line on the farm will still keep the feathers in the bed; the wrong kind will not.

Far more attention should be paid to the valuable reports that agricultural economics departments of our universities and colleges regularly issue. Nothing could be more incorrect than to think of these reports as academic or theoretical, remote from practical farmers' season-to-season tasks and worries. It is fair to say that every trend, whose economic pressure is now being felt by farmers, has been spotlighted in advance by these reports. Properly enough, it is said in the latest report from Cambridge—' Report on Farming, 1953 ' (1955, 36 pp., 4s.)—' in no case can the examination of farm records be considered as a substitute for good day-to-day management. It may, however, help to show hidden weaknesses in an otherwise well-managed enterprise.' Surveys of farming costs—provided that the number of farms in the group or groups is not too small—set *standards* and by comparing his own farm's performance a farmer can assess its weaknesses and strengths. In any complex business it is vital to be able to isolate the weak spots; recognising them, seeing how far they fall short of what is reasonably attainable, is more than half the task of correcting them.

Hitherto, our agricultural advisory services have tended to concentrate upon technical advice and farm

economists in the universities have worked somewhat separately. The Ministry of Agriculture has wisely published a first-class reference handbook on economic aspects of this work, ' The Farm as a Business ' (1954, pp. 107, 4s.). It provides not only many up-to-date average costs and prices for farming operations and produce, but it shows economic efficiency can be measured. Good technical advice and sound economic advice have always been close together. For the future they will be closer still; perhaps it is even more important that their likeness is to be given its long-needed emphasis.

Indian jute inquiry

THE Government of India has accepted the recommendation of the Jute Enquiry Commission that special attention should be paid to quality in future efforts to produce a higher proportion of the country's needs of raw jute. The Jute Enquiry Commission was appointed in August 1953 to look into the factors affecting production and marketing of raw jute and jute goods and the nature and scope of speculation in the trade.

The Government accepted the Commission's view that the Grow More Jute campaign should be directed towards improved quality rather than a mere physical increase in the volume of production in areas which may be unsuitable or uneconomic. The recommendation that the erection of new jute mills should not, as a rule, be permitted because of the existing idle capacity in the country was also accepted.

On the question of securing a fair return for the producer of raw jute the Indian Government does not consider that publication of fair prices by a government-appointed Jute Commissioner would prove of any real value in practice. However, the establishment of a future market, better transport and marketing facilities, and similar other measures recommended by the Commission should prove helpful in the securing of fair prices. Actually, the Government of India already have the necessary powers to control the price and distribution of jute goods and plans to have a similar reserve of powers in respect of jute are under contemplation.

The Government has also drawn the attention of the industry to some of the observations and suggestions made by the Commission. These relate among other things to the rational utilisation of the storage accommodation in Calcutta, vigorous market research and diversification of patterns of production, the raising of working hours to 48 a week, absorption of labour displaced from units which close down in mills, rehabilitation and development from their own resources; the latter means that the industry should keep down dividends.

Cotton and hormones

STRIKING increases in cotton yields have been obtained at the Institute of Plant Industry, Indore, by applying hormone-like substances during plant growth. Some years ago, a reduction in boll-shedding had been noticed in American work investigating reports of damage when 2,4-D was used for weed control with cotton. This indication was followed up using other growth-influencing chemicals and α-naphthalene acetic acid was found to exercise a particularly marked effect both on boll-shedding and yield of seed cotton.

Experiments with Indian cotton plants in the 1953-54 season have now shown that substantial yield increases can be obtained if α-naphthalene acetic acid is applied as a very dilute spray. The increases seem higher if spraying takes place at later stages of development, at the commencement of the fruiting stage rather than during the active phase of vegetative growth. There was little difference between results for spray concentrations of 10, 20 and 30 parts per million, so it may be assumed that a 10 or 20 p.p.m. strength is sufficient. Yields were increased by over 20%, the test figures for late sprays ranging from 22% to 27%. Earlier spraying gave yield increases between 10% and 21%. The detailed figures of these Indore tests will be found in *Nature* (**175**, 44, 1955).

A low-strength spraying operation that produces yield increases of this order, especially for an important economic crop, can hardly fail to be attractively economic in large-scale practice. This Indian research is to be extended. Further developments will no doubt be closely watched by scientists in all cotton-growing countries.

Acres under glass

A FEW weeks ago, among agricultural statistics records for England and Wales, the areas of glasshouses for July 1953 and July 1954 were published. Surprisingly, no contraction was shown. In fact, there was a slight increase, though one too small to be significant—4,651 acres in 1953 becoming 4,662 acres in 1954. This hardly reflects the background of economic difficulty that high costs and severe foreign competition are said to have produced for commercial glasshouse growers. The cropping pattern has changed very little: tomatoes still account for 60% of the acreage, cucumbers for slightly more than 10%, and among the floral crops, totally occupying about 13% of the acreage, carnations still dominate the picture.

It can, of course, be argued that growers who have sunk so much capital into this intensive type of horticulture cannot, in any case, withdraw from it, that they must continue to produce for better or for worse. In that view there is certainly some truth, but not enough

to explain the absence of a fall in acreage. Many glasshouses in the country are old-aged and exceptionally costly to maintain; if current results and future prospects are genuinely poor, a good deal of this acreage would inevitably be allowed to pass into obsolescence. To some extent this is constantly happening, but it is clear from the statistics that new glass is fully making up for old glass. Another pointer to stability is deducible from the fact that many of the old-established glasshouse businesses are situated today in thickly built-up urban areas. Their land value for building is attractively high and permission to sell for a non-agricultural use can often be obtained. This is a trend that should in theory be steadily reducing the total acreage under glass. Again, the statistical evidence that acreage is not falling shows that new sites and new glasshouses are taking the place of the old ones.

When they are available, will the figures for the under-glass acreage for July 1955 still show this same stability? We risk the prophecy that they will—despite further rises in fuel costs and despite imports of competing produce from sunnier climates. A population of over 50 million people with full employment is the best guaranteed market that glasshouse production can have.

Acres under water

THE standard advice offered to farmers whose land is subject to periodic flooding is to get the land drained. Often enough this is irritatingly empty advice. If the drainage work required is private and specific, it sometimes cannot be afforded by the farmer or provided by the landlord. In most cases, a large area requires a regional and large-scale drainage scheme, and field-by-field pipe-laying or ditch-cleaning is almost futile. The South-West branch of the N.A.A.S. is to be commended for giving attention to the problem of improving grassland quality on land of this type, and for suggesting what can be done to increase its production despite the fact that drainage and the flood risk cannot be changed.

In general, it is unwise to seek improvement by ploughing and reseeding grassland when flooding is annually persistent or even when it is experienced only once every second or third winter. Improvement in the existing sward must be sought by the use of fertilisers, good management and by such surface treatments as heavy discing or cultivating with a rotovator. The weed problem, usually severe in such land, can be reduced by using modern selective weedkillers. Experience has shown that land of this type is seldom in need of liming. This seems paradoxical, for land that is subject to high rainfall generally develops soil acidity with distressing speed; clearly, water from streams and rivers brings with it enough alkaline material to balance the free lime that is also washed out. However, in some cases liming may be badly needed and soil testing for lime requirement should not be omitted. Phosphate and potash are invariably deficient, the former nutrient usually being much the more seriously affected. However, a complete fertiliser policy is essential for, if the sward is to be improved during the limited flood-free period, growth must be rapidly encouraged by nitrogen as well. A niggardly fertiliser policy adopted simply because the land is flood-liable in autumn or winter is unlikely to be worth its trouble and cost; only a generous policy will bring a worthwhile return.

Where flooding is very occasional, spring ploughing and reseeding can be safely undertaken. The problem is not greatly different from that of improving normal grassland. Perhaps the most important point is to choose seed mixtures that will stand up to temporarily flooded conditions and which can compete vigorously with floodland weeds. Advice as to the more suitable seed mixtures can be given by regional N.A.A.S. officers.

Irrigation in India

READERS of the article on Spray Irrigation in our last issue will be interested in the results of an experiment carried out at the Indian Agricultural Research Institute, New Delhi, and described in *Science and Culture*, **20**, 292, 1954. It compared the normal method of irrigation in India — soil surface sheet-flooding—with overhead spray irrigation. The test crop was potatoes. Spray irrigation gave virtually equal yields whether as much water, three-quarters as much or half as much was applied during crop growth. That is to say, overhead spraying can produce yields just as high as those of sheet-flooding irrigation, but with only half the quantity of water. The quality of the tubers was also equal to that of tubers grown by normal irrigation.

Broadly speaking, overhead spray irrigation is practised in other countries today only for high-value crops or where soils are sandy and too permeable to hold surface-fed water. The costs of overhead spraying are appreciably higher. In the Indian test, it cost 146 rupees per acre as against 64.5 rupees for surface flooding; however, this is a misleading comparison, for the costs per acre of a more mechanised operation would be lowered if a larger acreage was treated. Even so, there cannot be any hope that overhead spraying costs can be brought down to the level of surface flooding costs. But in many areas of India water itself is scarce and has, therefore, a considerable economic value. Drought, too, is a major limiting influence upon crop yields in these areas. It may well be profitable to spend a greater sum upon the mechanical means of irrigating a crop if half the water required can be saved. This would seem to be a potential development manufacturers of spraying equipment should watch closely.

The Agricultural Revolution in Turkey—I

P. A. ORAM, M.A., DIP.AGRIC. (CANTAB.) and D. K. JONES, M.SC. (WALES)

FAO Mission in Libya — *Department of Agriculture, Cyprus*

There have been great advances in Turkish agriculture during the past 25 years, and a large increase in output has been achieved. In this article, the authors describe the agricultural position in Turkey and discuss the problems that are likely to arise.

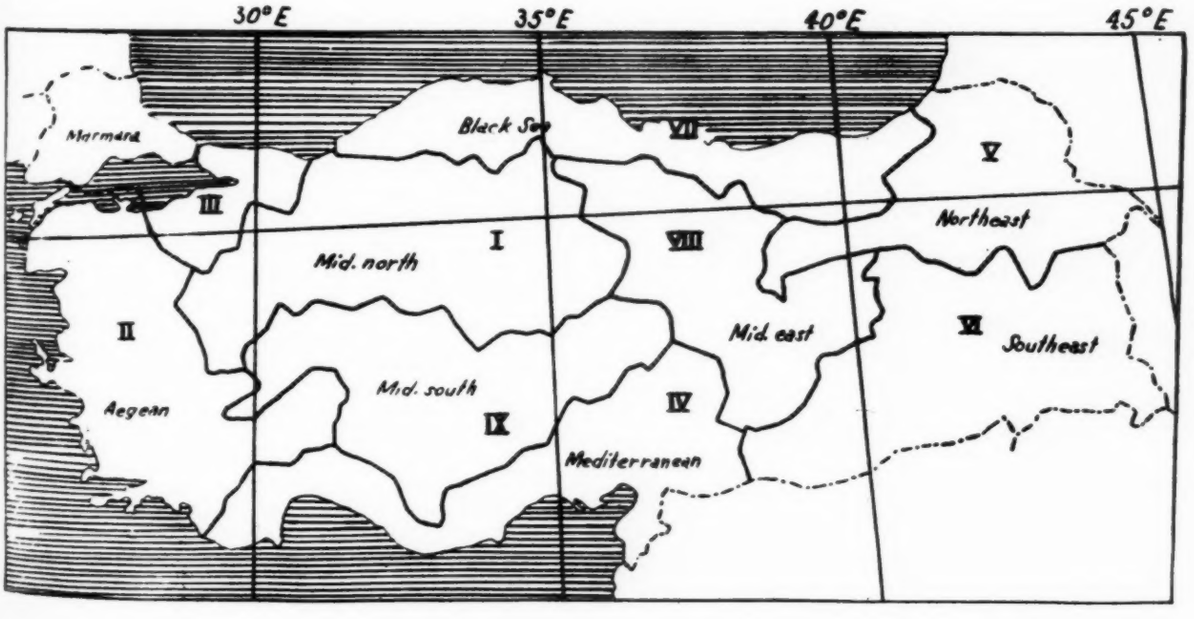
TURKEY, during this century, has progressed from the decaying remnants of the Ottoman Empire to a thriving community which exerts a powerful influence on world affairs, and particularly on those of the Near and Middle East. The impact of this renaissance upon agriculture has been profound, because approximately 80% of Turkey's population of 22 millions depend upon some form of husbandry for their livelihood.

These two articles will deal with the way in which Turkish agriculture has been remoulded and suggest means by which some of the dangers inherent in such a rapid expansion may be mitigated or avoided. The subject matter is based on travel in the regions marked I, II, III, VII and IX on the accompanying map during the 1954 Working Party on Mediterranean Pasture and Fodder Development, and subsequent training centre on the same subject, organised by FAO in co-operation with the Turkish Government. This provided opportunity for studying local problems and discussion with Turkish scientists and other experts from many countries. In a sense, therefore, these articles represent a distillation of ideas, although the authors do not wish to imply that those concerned in the discussions would agree with all of the views now expressed.

The main theme will be agronomic development, and particularly the integration of cash cropping, forage production and stock rearing, into a balanced farming system. Most of the points made are well appreciated by our Turkish colleagues, but it is felt that this external appraisal may contribute something to their planning. Moreover, the problem of establishing stable agricultural systems is crucial in many Mediterranean lands, where the pressure of expanding populations makes it imperative to develop new and more productive policies. Discussion of the experiences of a progressive country like Turkey, which has achieved a rapid increase in total production by superimposing recent farming techniques on an ancient and traditional agriculture, may, therefore, be of interest to other countries faced with a similar problem.

Agro-climatic zones of Turkey

The agricultural regions indicated on the map show considerable variation and present a correspondingly



The agricultural regions of Turkey

The sickle and (*below*) the combine harvester and all stages between can be seen at harvest

wide range of local problems. Regions I, VIII and IX, covering the Anatolian Plateau, have a modified continental climate, with hot, dry summers and very low winter temperatures. The limited rainfall of 250 to 300 mm. (10 to 12 in.) is distributed between October and May. This plateau, ranging from 500 to 2,000 metres above sea level, occupies a large proportion of the total area of Turkey and is the main cereal-producing zone. Regions II and IV, covering the south and west coasts, are Mediterranean in character, with hot, dry summers and cool, moderately wet winters. A very varied range of crops is grown both in summer and winter. Regions III and VII, adjoining the Black Sea, have a cooler, wetter summer than the previous zones, with mild winters and higher rainfall (750 mm. or above). Tea can be grown in suitable soils in the north-east and there is a large acreage of summer maize cultivation. Regions V and VI, which include the high plateau and mountains on the eastern border, have a high rainfall of 600 to 1,000 mm. and, although winters are cold, the area produces good pastures.

The size of the country is often not appreciated. It covers 78 million hectares (195 million acres), stretching about 1,700 km. from east to west, with a maximum width, from north to south, of 650 km. These distances present great transport problems. The railway network, although efficiently operated, is of insufficient mileage in a country so big, and the absence of a macadamised surface from most roads makes them unduly susceptible to weather, extremely dusty in summer and muddy in winter.

Methods adopted to increase Turkish agricultural production

There is no doubt that the increases in overall production achieved in Turkey since 1925 have been spectacular and offer a striking example of what can be achieved in a relatively short time by a determined government and people.

The methods adopted in achieving this rate of progress will repay closer examination, because, on the whole, they are a good model of how such a campaign should be planned and executed.

Cropping policy

Expansion has been based largely on a rapid and unprecedented development of mechanisation, which has enabled a ' plough-up ' campaign to be carried on comparable to that undertaken in Britain during the 1939-45 war. This has necessitated a policy of concentration on annual crops, particularly wheat and barley, which are susceptible to mechanised handling, give a quick turnover and are well adapted to the Turkish climate. Certain dangers inherent in this policy will be discussed later.

Mechanisation

Until recently the acreage which could be grown in any one year has been limited by the primitive equipment available. Large-scale importation of tractors and other modern agricultural equipment, as shown in Table 1,[1] has changed this situation. Increased availability of medium-term credit (four to six years) for purchase of this equipment and the provision of 8,000 of the tractors by Marshall Aid have been important contributions. Grazings unploughed for generations are being cropped and much land that would otherwise be fallow in a cereal-fallow rotation can now produce arable forage.

Numbers of combine harvesters are not given in the authority quoted, but, according to Irkun,[2] 10,000 combines were in use in the summer of last year. On a day's journey across the plateau at harvest time, reaping hooks, scythes, reaper-mowers, binders and combine harvesters can be seen in ascending order of technical evolution.

TABLE 1

IMPORTS OF SOME AGRICULTURAL EQUIPMENT DURING 1946-52

Type	1946-49	1950	1951	1952	*Total*
Tractors	2,227	5,877	12,810	13,566	34,480
Ploughs (tractor) ..	3,310	9,997	9,914	20,380	43,601
*Ploughs (other) ..	7,143	9,444	7,976	4,138	28,701
Drills (grain) ..	1,264	3,216	3,226	9,791	17,497

*Excluding local production of animal-drawn ploughs.

Cereal production

Fig. 1 shows an increase in cereal production parallel to the increase in mechanisation. Actual yields, however, are still low and a rising trend shown in recent years was reversed in 1954, a year of inadequate rainfall in Anatolia.

Research to improve yields is carried on at a number of centres, including Istanbul and Eskisehir. Unrivalled opportunity for selection and breeding of cereals exists, and this applies especially to wheat. Anatolia has an abundance of types and is considered to be one of the centres of maximum diversity of wheat, strains of Vulgare, Durum, Persicum, Compactum, Turgidum and Polonicum being found in great variation.[4] The most formidable problems under investigation are resistance to drought, cold and disease. Among the thousands of selections made by Prof. Osman Tosun at Ankara University are wheat-rye hybrids, which he has bred to combine the quality and high-yielding capacity of the former with the tolerance to cold, drought and low fertility of the latter. Disease investigations include the development of varieties resistant to rust, in particular to *Puccinia graminis*, and to bunt (*Tilletia caries*), although no highly resistant strains are yet grown commercially.

The introduction and widespread use of chemical seed-dressing has been of great value in the control of bunt and other seed-borne cereal diseases. As the production of seed under Government auspices develops, the treatment of all seed before distribution to farmers should become a routine practice, which will contribute much to raising cereal yields. Controlled seed production is at present carried out largely on state farms. These large mechanised units—often of more than 20,000 hectares (50,000 acres)—produce more than 10% of Turkey's seed requirements. In spite of this, farmers' stocks are not good; wheat is often contaminated with rye and barley as well as with other varieties and species of wheat. The original Government programme, which called for an eventual production of 20% of the country's seed requirements, will therefore be augmented by a plan to use that of private farmers and an accompanying certification scheme is being prepared to maintain standards. The target is an annual production of 600,000 tons of cereal seed.

Production has been greatly stimulated by guaranteed minimum prices for cereals. Government Agency purchases of surplus production rose from 330,000 tons in 1951 to over 1,200,000 tons in 1953. One problem which arises from this rapid increase is that of storage. Village and small town storage facilities were never intended to cope with such quantities, and as a result losses through spoilage have been severe.[3] Help from the Mutual Security Agency, and now from the Foreign Operations Administration of the United States, is making a big contribution. The type of light metal silo holding a moderate quantity of seed, seen in one Anatolian town, may prove the solution to this problem. Not only are these silos inexpensive, but they can be speedily erected (or dismantled) as and when required. They therefore constitute a mobile reserve ideally suited to a rapidly expanding production, particularly in semi-arid areas, where quite small rainfall fluctuations can produce sudden grain surpluses.

Discriminating foreign buyers have in the past shown lack of interest in Turkish wheat because of the unsuitable storage conditions and mixed nature of the stocks. The energetic steps being taken to produce and distribute pure seed and to improve storage facilities should do much to restore confidence.

Rotation and the development of crops other than cereals

Cereal cultivation, which forms the mainstay of Turkey's cropping is largely monocultural and is based on a simple cereal-fallow rotation.

This system is common in the Near East, but in certain countries, notably Cyprus, Greece and Israel, great efforts are being made to modify it to include some forage crops. Despite agronomic and sociological difficulties, considerable progress is being made,[6] and the problem of developing more

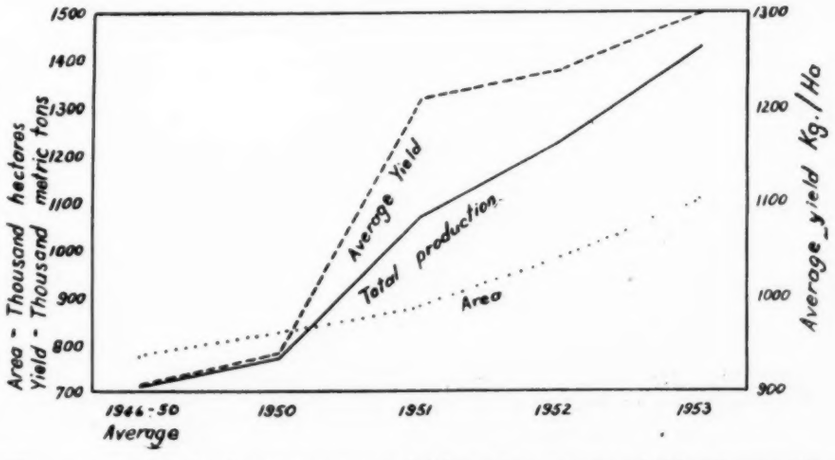


Fig. 1. A graph showing area, yield and average yield of cereals during the period 1946-53

productive systems in the Mediterranean environment does not seem to be insoluble. The argument usually advanced to support the cereal-fallow system is that two years' rainfall is required to produce one cereal crop in the winter rainfall zone in areas of low precipitation. In Cyprus, this has been disproved in places with an average rainfall as low as 350 mm. (14 in.). In similar areas of Israel, fallow has almost been superseded by a rotation of winter cereals, summer crops, such as sorghum and sunflowers, followed by a winter legume for hay. The value of fallow in Cyprus has been shown to be the accumulation of nitrogen, and perhaps phosphate, during the resting period,[5] and this may also be true of Turkey, where soils tend to be very deficient in these two elements. In Libya, where conditions are even more arid, there is a serious nitrogen deficiency, which may be mitigated by the fallow, but there is no evidence to show that soil moisture is maintained at a more adequate level by cropping in only one year out of two.

It might seem, therefore, that Turkey, which has in many regions a more generous rainfall than the countries mentioned above, should be developing a better balanced system of farming. Efforts are being made, but certain difficulties make it necessary to proceed with caution. The cereal-fallow rotation has always proved well suited to peasant agriculture where moisture is limited. The sowing season is short and critical under such conditions and the farmer, using primitive tools and draught animals, cannot plough all his land in the time available each year. In addition, the fallow is a means of ridding the land of weeds, although neither this argument, nor that of conserving moisture, is valid when the farmer takes a crop of weeds for forage off his fallow, usually after they have seeded, a common practice in the Middle East. Shortage of fertilisers to replace the recuperative value of fallow has hindered progress and an increase in fertiliser consumption from 10,000 to 100,000 tons[2] is still small compared with the size of the country. However, in the light of recent developments, it should be possible to overcome these difficulties. The advent of the tractor, steel plough, drill and combine harvester, particularly when operated on the village co-operative basis now common in Italy, has greatly increased the amount of land which can be cropped yearly by a peasant community. Fertilisers are more readily available and more easily handled and stored than was the case some years ago. Selective weedkillers make control of many weeds in cereals simple and economical, and one of the commonest arable weeds in Turkey (*Boreava orientalis*) is a cruciferous species very easily controlled by 2,4-D.

A further consideration which may support the retention of the cereal-fallow system in parts of Anatolia is the fact that this region has a continental climate and in such an environment the fallow may have more value than in the Mediterranean zone. In certain of the Prairie Provinces of Canada with such a climate the cereal-fallow rotation is now accepted as a suitable form of land use. Research indicates that a fallow does accumulate moisture under these conditions, and it is held that the cereal stubble provides all the necessary organic matter and that any more reduces wheat yields.

Nevertheless, many Turkish scientists believe that cereal monoculture is undesirable and that the fallow is an anachronism in the light of advances in farming techniques. Work to develop better systems and fresh crops is therefore advancing slowly along the following lines.

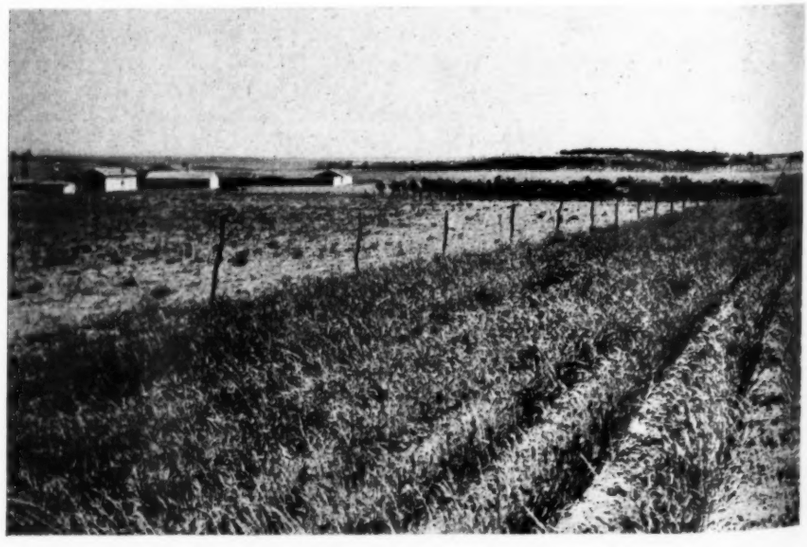
Fodder crops

Research is being undertaken on a moderate scale and adaptation trials of introduced species and selected local ecotypes are proceeding at a number of centres. In addition, excellent extension work is being undertaken to popularise local strains of *Medicago sativa* and *Onobrychis sativa*.

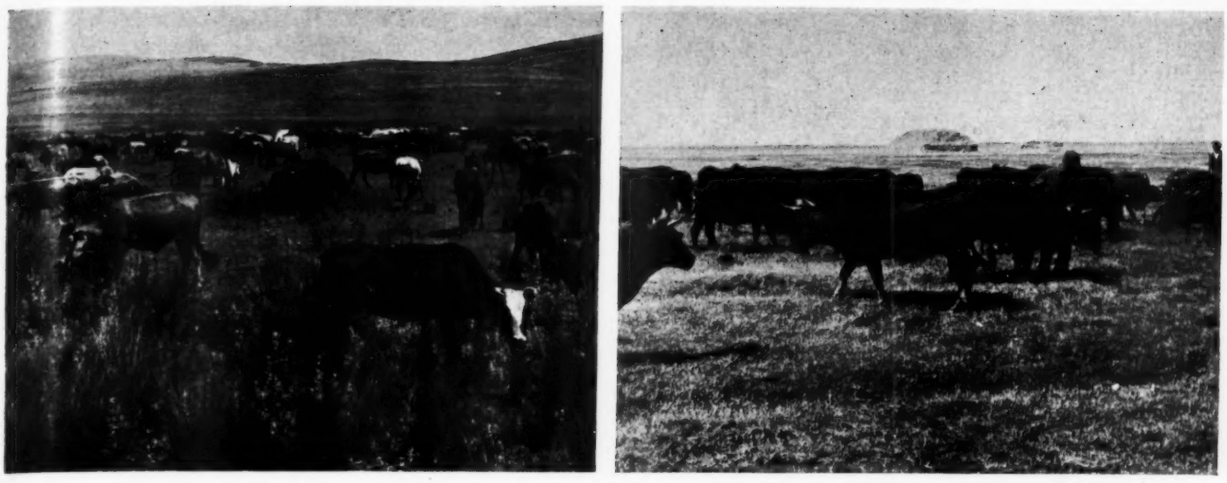
These two species are used for short-term leys in arable rotation, for pasture reseeding without irrigation in areas with a rainfall as low as 300 to 350 mm. and for irrigated forage. Encouragement is being given by the Government to village co-operative cultivation. Local plans vary slightly, but generally the village provides land and labour, the Government provides machinery, seed and fertilisers, and the produce is divided amongst the villagers according to the livestock each possesses. In addition, certain 'pilot' farmers are selected and assisted in the cultivation of these crops in the hope that other farmers will follow.

Lack of seed is limiting expansion of this most valuable programme and if a scheme for seed production under Government auspices could be given high priority it would contribute greatly to the development of rotational farming and consequently to a better supply of forage.

The development of annual forage legumes to replace fallow in the arable rotation is also receiving attention. A



Grasses sown in rows compare favourably with the overgrazed land outside the fence



Stock on the village pastures (*left*) **do not compare with those on the State Farms** (*right*)

leafy, vigorous form of *Vicia narbonensis* selected by Prof. Tarman at Ankara University is promising, but many types of *Vicia* and *Lathyrus* could be grown. In Greece *Lathyrus cicera* has proved of great value, and in Libya *Lathyrus sativus* appears tolerant of arid conditions, whereas in Morocco another approach is being made by the selection of strains of *Vicia sativa* with different times of maturity, thus allowing considerable flexibility in harvesting dates.

Industrial crops

The development of the sugar-beet industry has been one of Turkey's major agricultural achievements. The sugar-beet factory in each district serves as the centre for seed production, research and advisory work concerning the crop. Foundation seed is imported, multiplied on the sugar-factory farm and distributed to the farmers. Rotations including legumes have been adopted and are being enforced on contracting farmers. Even so, some crops seen on private holdings fell far short of the high standard set by the factory farms, and the producers' yields, which average 14 tons per hectare, are low. Organised visits to the factory farms would help to stimulate adoption of improved practices, both in cultivation of sugar beet and in the use of its by-products, since the brown Swiss cattle at Eskiseher factory, fed on a ration based on beet pulp, compare with the world's best commercial herds.

Pastures

To expand the acreage of cereal cultivation much grazing land as come under the plough, some for the first time. This has greatly increased pressure on remaining pastures, which in many parts of Turkey were already over-grazed. In the light of the urgent needs of a country which has transformed its economy in a few decades, this was almost unavoidable, but to continue such a policy may result in serious depletion of the fertility of the soil. This will be discussed in more detail in the next article.

Unfortunately, pastures are particularly poor on the Anatolian Plateau, where the expansion of cereal production has been greatest. In this area *Alhagi camelorum*, *Artemisia fragrans*, *Eryngium campestre*, *Salvia cryptantha* and *Thymus squarrosus* abound, while such species as *Aegilops ovata*, *Agropyrum cristatum*, *Astragalus* sp., *Bromus cristatum*, *Stipa pennata* and *S. pulcherrima* supply the 'better' grazing. In more favourable situations, and this usually means where water supply is more abundant, better species occur, and the following list was made on a brief inspection of the flora in one of the higher (1,000-metre altitude) areas of the north-west: *Achillea millefolium*, *Bellis perennis*, *Cynosurus cristatus*, *Lolium perenne*, *Lotus corniculatus*, *Phleum* sp., *Trifolium fragiferum*, *T. hybridum*, *T. pratense* and *T. repens*. However, grazing management is often unsatisfactory, animals remaining on the pasture long after they should have been moved to a fresh 'bite' and suffering accordingly from undernourishment and an excess of internal parasites.

Plant nurseries have been established to examine the possibilities of exotic and selected local species in pasture improvement. Promising indigenous strains exist, of which greater use could be made. In the Black Sea area, *Trifolium repens*, *Lolium perenne* and *Dactylis glomerata* were observed growing profusely in scrub woodland, although they had been eliminated from pastures by over-grazing. Fortunately, there seems to be an awakening interest in the need for research on the management aspects of pasture improvement. At the farm school near Amasya a rotational grazing experiment has been started, co-operative improvement of forest grazings by control and fertiliser application is under way in some village areas and reseeding experiments are being carried out on state farms, both with and without irrigation.

It appears that in the immediate future concentration on the improvement of management techniques may give most rapid and economical results. Development of water resources could greatly increase the area of productive pastures and utilisation of underground supplies to provide more irrigated fodder would be particularly valuable in remote areas, where inaccessibility makes irrigated cash crops uneconomical. Control of surface and sub-surface water is most necessary. Much land in valley bottoms suffers from flooding in spring and inadequate supply in summer and autumn, and pastures were seen which, although otherwise well managed, were still not fully productive because this fundamental limitation existed.

Livestock improvement

The feeding regime, of relative abundance in spring and early summer followed by near starvation for the rest of the year, corresponds to that of nearly every other Mediterranean and Near-East country and dictates the type, quality and productive capacity of the animal carried. As is usual under such circumstances, the number of livestock is the maximum that can remain alive. Production per head is extremely low and improvement will be possible only when the farmer realises that the provision of adequate nutrition for his stock throughout the year can also enable him to raise his own standard of living.

The quality of animal and standard of management in the villages is disappointing and provides a striking contrast to that at state farms and haras (stud centres). However, with the assistance of these centres, the genesis of a sound livestock programme is emerging. Local cattle are being 'graded-up.' For instance, the Yerlikara (local black), which produces female animals with a body weight of 350 to 400 kilos (7 to 8 cwt.), yielding 1,500 to 2,500 litres (3,300 to 5,500 lb.) of milk in a lactation, with 6% butter fat. These improved local types are being crossed with imported breeds, including Brown Swiss and Hungarian cattle. Importation of such breeds, as well as Jersey and Herefords for pedigree herds, is also planned.

A number of local breeds of sheep exist and the policy of crossing these with the Merino to produce an improved fleece appears sound. In this connection, it was interesting to visit the wool processing factory at Bursa, which was supplied with 95% of its wool from Australia. A fertile field of development is obviously available here, because this factory alone could handle the wool from a million Merinos. The ancient need for a triple-purpose sheep giving milk, wool and meat would disappear if forage supply improved, because cattle could meet the milk needs of the villages.

Animal breeding programmes are largely the responsibility of the haras, but now state farms are taking an interest. There is a golden opportunity for research and demonstration at these centres concerning the development and conservation of better fodder supplies and their integration with livestock improvement.

The widespread ploughing of land previously available for grazing, as well as the dictates of economic and social progress, renders the development of more intensive livestock husbandry imperative, and this will not be possible unless animals can be better fed. Cultivation of more arable forage, irrigated and dryland pastures, plus improved methods of conservation, will release the pressure on extensive grazings, which can then be properly controlled and managed. This will help to check the ravages of water erosion, which tend to deplete still further the land available to livestock. The ensuing all-round improvement will allow more productive animals to be kept, but until it can be achieved the capacity of the livestock will be limited by their environment and all efforts of the breeders are likely to be vitiated.

Here is a challenge as much to the plant breeder and the agronomist as to the livestock expert. For this reason it would seem desirable to adjust the balance of staff at state farms and haras so that fodder supply and its integration with livestock is given equal weight with animal breeding. The highly competent veterinarians usually in charge of such stations should be assisted by agronomists and animal husbandry specialists if the livestock improvement policy is to achieve its potential. The subject of staff leads naturally to that of education, since the supply of trained agriculturists will be a critical factor in Turkey's development.

Education

The impressive progress of agriculture in Turkey during the last 25 years has been achieved to a considerable extent by the local adoption of extensive methods developed elsewhere. Further improvement will increasingly depend on the intensification of cropping, higher yields and, above all, on the integration of crops and livestock into more balanced systems of husbandry.

Success will demand vigorous research as well as imaginative administrative policies. Shortage of scientists and technicians may be the most important limiting factor. Good training facilities exist at universities and agricultural high schools, but numbers, particularly of extension officers, are not at present adequate. Certain students at the state farms are trained to return to their villages and become group leaders. This is a valuable scheme, which has yet to develop its full impact on the rural community.

In this programme, there is evidence of lack of balance in the field of agriculture as a whole. Crop and livestock integration is insufficiently emphasised and veterinary medicine overshadows other aspects of animal husbandry. To amend the curriculum so that the balance is restored will be an important step in educational policy.

Summary

Immense advances have been made in Turkish agriculture during the last 25 years and output has increased enormously. Self-sufficiency has been reached in cereal and sugar production, and well-developed plant breeding, seed production and advisory services indicate the great efforts made by the Government to stimulate cultivation of these crops. The problems associated with the advent of mechanisation and expansion in arable acreage, such as shortage of mechanics, workshop facilities, inadequate supply of fertilisers and lack of storage space, are being tackled with determination. These achievements represent a striking example of what a determined administration and a co-operative people can do, which other countries with similar problems could study with profit.

The limits of progress along present lines may not yet have been reached, but the methods adopted have been, inevitably, somewhat exploitive in character. The time is approaching for the emphasis on cereal production to give way to a more balanced system of agriculture involving the cultivation of crops for animals as well as human consumption and the closer integration of crops and stock. This should be phase two of the agricultural revolution. There appear to be great possibilities for the complementary development of related industries, such as the production of fertilisers and fencing material, and meat, milk and wool processing.

To develop this new phase will require not only an effort on the part

Continued on page 164

The Improvement of the West African Natural Palm Groves

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Deputy Director, West African Institute for Oil Palm Research

THE West African Institute for Oil Palm Research differs markedly from other tropical research institutes in the type of industry it serves. Whereas the rubber, tea and coconut research institutes of the Far East serve both plantation and peasant industries, and the Cocoa Research Institute of West Africa serves peasant smallholdings alone, W.A.I.F.O.R. studies a crop which is exploited rather than cultivated and serves an industry which is interwoven with the shifting cultivation of food crops and is based on complicated systems of land use and tenure. The institute finds itself in the peculiar position of studying the planting and cultivation of a crop which, though ubiquitous, is hardly ever planted or cultivated. It might perhaps be asked whether this is in fact worth-while, and indeed it is only likely to be worth-while if either a definite attempt is made to improve the yield and quality of the products of the palm groves or increased production is sought by opening plantations in the more thinly populated areas of the forest belt.

The work of the West African Institute for Oil Palm Research is complicated by problems of shifting cultivation and systems of land use and tenure. In this article, the author discusses these difficulties and describes the institute's work on palm grove improvement.

The institute, the organisation of which has recently been described in its own journal,[1] is well equipped to give advice on the ordinary problems of planting practice, but it cannot assume at the outset that the semi-wild palm groves are going to sink into oblivion and be replaced by vast plantations established on the fringes of the palm belt. This belt (Fig. 1), particularly in Eastern Nigeria, supports a teeming population. Plantations in Nigeria at present produce under 10% of the palm-oil exports and less than 2% of the palm kernels; they may in the future become very important producers of palm oil and kernels, but the fact remains that the present production of the groves is the life blood of Eastern Nigeria and of considerable importance in other parts of West Africa. Increasing competition from plantations in the Belgian Congo and elsewhere will hit these groves first and hardest. The institute must, therefore, investigate the production of the groves and seek means of improving it.

Early work

In Nigeria, thought was given to the improvement of palm groves as long ago as the early twenties when a committee was appointed ' to consider the best means of securing improved and increased production of palm oil and kernels in West Africa.'[2] The conclusion of this committee that ' clearing the heads and opening up the bush ' was the best method of increasing production did not meet with the approval of the Department of Agriculture, but it led to a limited number of palm-grove improvement

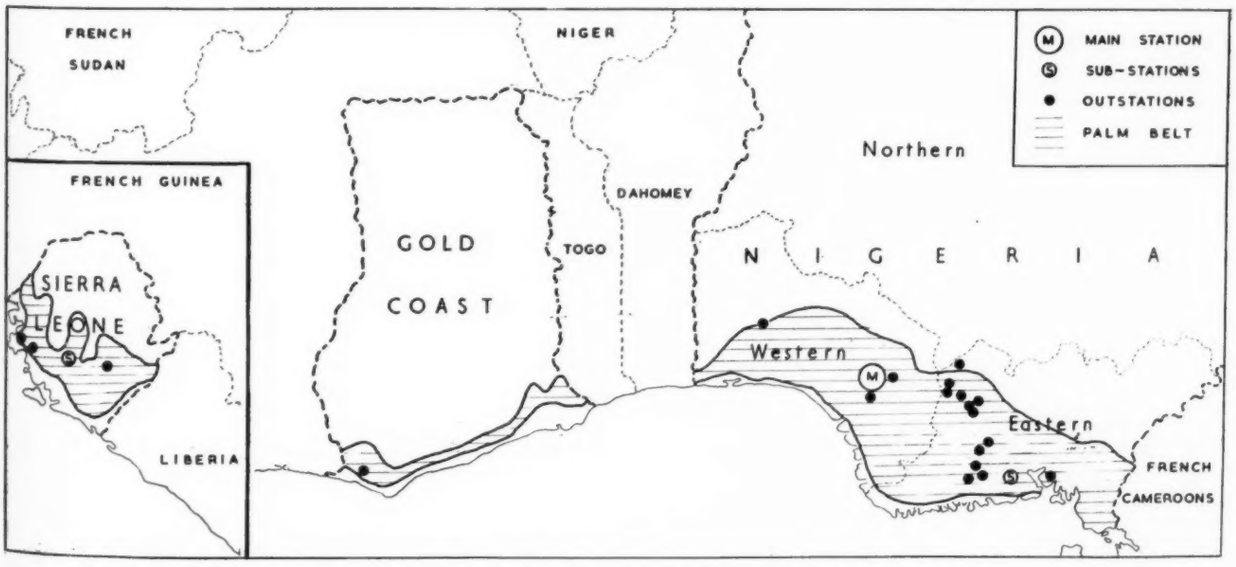

Fig. 1. The palm belt in the British territories of West Africa showing W.A.I.F.O.R.'s present or intended activities within it

TABLE 1

PALM GROVE EXPERIMENTS AT EKIADOLOR AND ABA

Mean number of palms and yield of fruit bunches per acre plot

	Treatment	Wild palms	Planted palms	Mean yield of fruit bunches per acre per annum			
				1938-41	1942-45	1946-49	1950-53
				lb.	*lb.*	*lb.*	*lb.*
Ekiadolor	1. Untreated..	58	—	2,164	1,896	1,200	1,230
	2. Replanted, bush cleared regularly ..	10	55	4,823	3,757	3,164	3,515
Aba ..	1. Untreated..	96	—	1,551	1,875	1,431	1,110
	2. Replanted, bush cleared regularly ..	12	44	2,443	1,747	1,586	1,957

trials. The suggestion was not, in any case, one which was applicable to large areas of grove in Eastern Nigeria since the intensive food cropping which is carried on over wide areas of grove makes special 'opening up of the bush' unnecessary and in many areas it is already too frequent.

Eleven trials were started at six different centres in Southern Nigeria between 1927 and 1929. In the 'treated' plots all palms under 25 ft. in height were removed and unselected seedlings were planted up underneath the remainder at the rate of 60 to the acre. The taller palms were gradually cut out, as far as the grove owners would permit, during the time the young seedlings were coming into bearing. These trials were unsatisfactory in many respects and were not representative of conditions in the main palm belt, but an indication was certainly obtained that small increases in yield could be gained by such methods. All trials except two were discontinued after a few years and a campaign for palm grove replacement and for the planting of new plots was started. The former met with little or no success and the latter was successful only in areas, outside the main palm-growing areas, where land was plentiful.

Trials

The two trials which were continued have been maintained up to the present day, and although they suffered from some of the disadvantages of the other plots they are of particular interest because their records cover a fair period of time and because one plot, Aba, is in the heart of the palm belt on the impoverished soils of Owerri Province, while the other, Ekiadolor, is in 'palm bush' country in the more fertile and sparsely populated areas of Benin Province in Western Nigeria. It has to be remembered in considering the history of the plots that unselected planting material was used and no attempt was made to maintain yields by the use of fertilisers or by any other means. Yields of the planted palms might, therefore, have been expected to fall after 10 years or so.

In each trial, there were five untreated plots in which the undergrowth remained uncut, and four treated plots in which replacement had been carried out and the undergrowth was regularly cleared by cutlass as in a plantation. Table 1 shows the mean composition of these plots and their yields from 1938 to 1953. The records of Ekiadolor also cover an earlier period but these are not included here. Planting in the treated plots was carried out in 1927.

The replanted plots at Ekiadolor reached their peak of production in the four-year period 1938-41 and then gradually declined. Though earlier figures are not available it is probable that the Aba replanted plots also reached their peak in the same period.

The main points of interest which have emerged from these two trials are: (1) that on the impoverished Aba soil replanting with unselected seedlings and retaining an average of 12 old palms per acre have failed to raise yields above 2,500 lb. of fruit bunches per acre and, for a short period, the untouched stand of wild palms has given a higher yield than the replanted plots; (2) that on the more fertile Ekiadolor soil the replanted plots have managed to give double the yield of the untouched plots but have only exceeded 4,000 lb. of bunches per acre for a short period; (3) that the planted palms in the treated plots at both centres only managed to provide about half the yield from 10 years of age onwards; and (4) that at Ekiadolor the few remaining wild palms in the cleared plots have continued to produce as much as has been produced from six times their number of palms in the untouched plots.

The problem

The main lesson to be learnt from the trials just described is that, without any special measures being taken to increase and maintain productivity, simple replanting with unselected material in a palm grove in which a few old palms are allowed to remain is unlikely to increase yields to a satisfactory plantation level even if the area is regularly cleared by cutlass. It has been necessary, therefore, to consider the problem of palm-grove improvement from two angles. Firstly, what are the requirements for the maximum development of the oil palm under West African conditions? Secondly, what are the present conditions of growth and yield of palms in the great areas of natural palm groves? The second question will be discussed first.

Present conditions

It is of little use attempting to improve agricultural production if knowledge of what one is trying to improve is lacking. Statistical information concerning the palm groves is very scanty and the institute has in recent years set about obtaining such information by studies of two kinds: (1) a palm-grove survey in an area of Calabar Province in Eastern Nigeria, and (2) a detailed examination of palm groves owned or leased by the institute at its sub-station in Calabar Province and at the main station.[3]

The present status and composition of the palm covered areas of Eastern Nigeria are the result of the particular agricultural practices and social habits of the people. The 83 plots of the survey mentioned above are situated on the land of the Asutan Ekpe clan near Nung Udoe (Fig. 2) and they have been classified on an ecological basis by Dr. J. M. Waterston[4] in consultation with Mr. B. V. A. Attah. Palm groves are believed to have evolved both from original homestead areas in the forest and from open farmlands on which shifting cultivation, or 'bush rotations,' are practised. In the homestead areas,

palms tend to come up thickly around the houses and eventually the compounds become so dense with palms that the people, ever reluctant to fell a palm, abandon their homes and move off elsewhere, usually into the farmland. The palms left behind form the typical dense groves of the palm belt but they are not so dense that, in an area of high population, they cannot often be made to produce food crops as well as palm bunches. The coco-yam is a favourite shade-tolerant crop for planting in these groves.

Palms soon spring up around the new homesteads in farmland and new compound palm groves are formed in this way. Palms may also spring up quite thickly in farmland without the agency of man; nuts are easily spread about by pigs and other wild animals. Lastly, new farmland, with palms growing more or less thickly in it, may be formed from degraded palm groves when deaths have exceeded natural regeneration.

Natural palm groves may, therefore, be classified as follows:

(*a*) *Primary compounds.* Here the palms are growing around original homesteads.

(*b*) *Typical dense groves.* These will show evidence of abandoned homesteads.

(*c*) *Degraded groves now used as farmland.*

(*d*) *Original open farmland.* Certain areas of farmland will contain volunteer palms.

(*e*) *Compounds in farmland.* Here the palms are growing around a homestead set up in farmland.

The survey contains plots of all these five types of grove and one plot in which palms have been planted in farmland.

As is usual in surveys of this kind, some difficulty has been found in obtaining the full co-operation of the people. Thus, while useful information has been obtained on the stand of palms in each type of grove, on the average bunch weight and on the fruit types and forms, complete accuracy of yield figures could not be assured and those obtained between 1949 and 1951 were thought to underestimate the true figures by about 20%. Only three original compound plots of varying sizes were included so that, except perhaps for figures of fruit form and weight per bunch, data from this group were of little value.

TABLE 2
PALM GROVE SURVEY NEAR NUNG UDOE, EASTERN NIGERIA
Mean number of palms per acre in 1952

Grove type	*Number of plots*	*Mean number of palms per acre*		
		Smooth-stemmed	*Rough-stemmed*	*Total*
(*b*) Typical dense groves	40	38	43	81
(*c*) Degraded groves now used as farmland	15	35	25	60
(*d*) Original open farmland	11	23	14	38
(*e*) Compounds in farmland..	13	21	25	46

Table 2 shows the number of plots of the four main grove types together with the number of smooth-stemmed and rough-stemmed palms to be found in each. A smooth-stemmed palm is one which has lost its leaf bases, and in practice it is found that the great majority of rough-stemmed palms are not yet in bearing.

The low proportion of rough-stemmed palms in farmland plots is perhaps not surprising as young palms would have a poor chance of developing during farming operations in these relatively open areas. The number of palms in the (*c*) plots is still very high, and the indication is that these areas are taken for farmland when degradation from true grove has not proceeded very far. So-called true grove must, in fact, merge imperceptibly into degraded grove. The number of palms in the compound areas near homesteads in farmland (*e*) are not very great but the predominance of rough-stemmed palms indicates that the number is probably increasing. Here, in contrast, the reverse process is taking place and farmland is merging imperceptibly into grove. In many places it would be difficult to say where one ended and the other began.

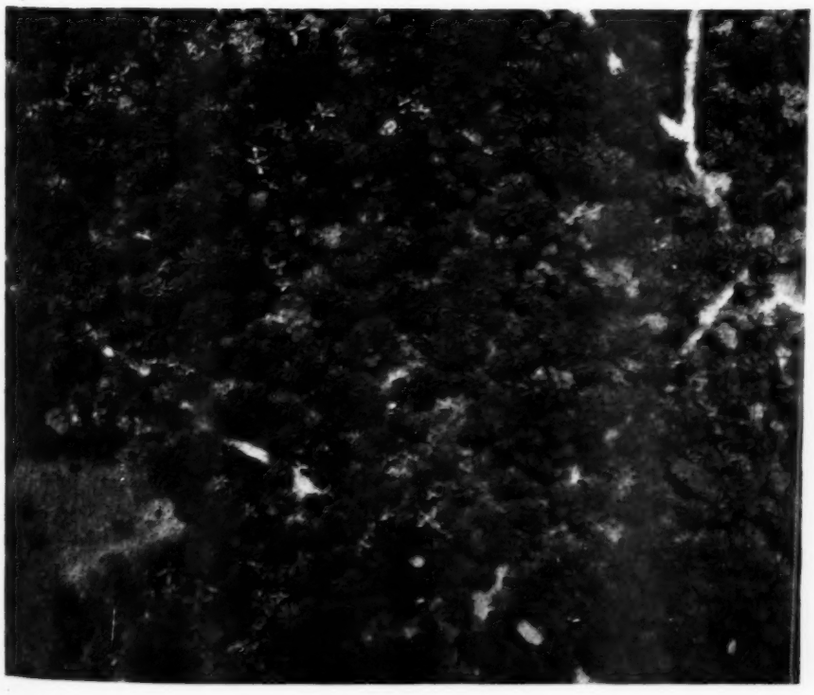

Fig. 2. An aerial view of part of the area surveyed at Nung Odoe

Fruit forms

Of particular interest was the proportion of the different fruit forms found in the different grove types and the weight of the bunches. All bunches harvested between 1949 and 1952 were recorded as *macrocarya*, the very thick-shelled form with a very low percentage of the oil-bearing mesocarp, *dura*, the ordinary thick-shelled form with a low

percentage of mesocarp, and *tenera*, thin-shelled fruit with a high percentage of mesocarp. Table 3 shows both the percentage of each fruit form and the mean bunch weight for each type of grove. It will be obvious at once that all areas, and particularly farmland, have far too high a proportion of low-oil-producing forms, and that bunch weight decreases as one moves from compound areas through dense groves and degraded groves into farmland.

Yield figures

While any conclusions drawn from the yield figures obtained must, for reasons already given, be tentative, differences have been sufficiently striking to deserve comment. In order to reduce the effect of density, the plots have been classified according to the number of smooth-stemmed palms they contain and the yields of fruit bunches harvested from 1949-51 are recorded in Table 4 (in pounds per acre per annum) for the four main grove types.

It will be noted that the dense groves derived from original compounds give the highest yield in all density groups while the farmland palms give the lowest yield. Yield increases with density at least as far as 50 smooth-stemmed palms per acre.

The results so far obtained from this survey show that the proportion of low-oil-producing fruit forms is far too high and there is an indication that yield trends are in a downward direction. If dense groves are gradually giving place to degraded groves and thence to farmland then both the average bunch weight and yields must be decreasing. The setting up of homesteads, with their ' compound palms,' in farmland causes some recovery of yield and bunch size, but the large size of bunches in the original compounds and in typical dense groves is not regained and yields do not appear to approach those of the dense groves. Fragmentary as this information may be it is hard to obtain any other picture than one of declining production per acre. In most parts of Eastern Nigeria, population pressure is too great to allow any area to revert to secondary forest for a recuperative period.

That yield per acre may be declining in heavily populated areas does not mean, of course, that Nigeria's production is likely to show any marked decline. There are many areas, even in Eastern Nigeria, where the palms are never fully exploited. If, for instance, increased harvesting is encouraged by the setting up of a mill, production of oil and kernels in the district may be expected to rise.

Abak groves

Detailed examination of the production of the institute's groves at Abak in Eastern Nigeria has only just begun, but an examination of the yields of 1-acre plots in a very dense grove has given some interesting and rather surprising results. In spite of its extreme density, it was found that the densest parts of this grove were giving the highest yields. These yields could exceed 5,500 lb. of fruit bunches per acre. Even though some areas were holding more than 80 smooth-stemmed palms per acre there was no indication that the optimum density for maximum yield had yet been reached. Moreover, these dense areas gave the heaviest bunches. The relationship between density and yield and bunch weight in this grove is shown in Fig. 3. The three-acre plots with over 70 smooth-stemmed palms are omitted, but their individual yields were 5,515 lb. from 95 palms, 5,898 lb. from 87 palms and 4,824 lb. from 102 palms.

Further examination of this grove showed that there was a high-fertility area in which, though yields still increased with density, bunch weight was almost constant. There was a strong indication that high-density plots were on the more fertile areas. In some plots, trunk rot caused by *Ganoderma* sp., was found to be a major cause of reduced density and hence, presumably, of reduced yield. There is little doubt that, with palms of all ages and their crowns at different heights, a natural palm grove (Fig. 4) can bear a much higher density of palms than can a plantation field planted in one year. There is no case, from data so far examined, for the 'thinning out' of groves which is sometimes advocated. Before groves such as the one described are thinned out it must be known without doubt that something considerably better than the thinnings can be put in their place and that planned regeneration or replanting will be successful.

Nutrition problems

Turning now to the requirements of the oil palm for its maximum development under the climatic and ecological conditions of West Africa, one is at once

TABLE 3

BUNCH FORM AND WEIGHT IN SIX GROVE TYPES

Percentage of bunches of *macrocarya*, *dura* and *tenera* fruit forms, and weight per bunch

Grove type	*Percentage of bunches of three fruit forms*			*Weight per bunch*
	Macrocarya	*Dura*	*Tenera*	
				lb.
(*a*) Primary compounds	31	47	22	38.7
(*b*) Typical dense groves	23	65	12	33.9
(*c*) Degraded groves now used as farmland	24	61	15	32.1
(*d*) Original open farmland	29	55	16	23.6
(*e*) Compounds in farmland	22	65	13	31.5

TABLE 4

FRUIT BUNCHES HARVESTED FROM NUNG UDOE SURVEY PLOTS, 1949-51

In lb. per acre per annum

Grove type	*Number of smooth-stemmed palms per acre*					
	1-10	11-20	21-30	31-40	41-50	51-60
(*b*) Typical dense groves	—	2,156	2,568	2,617	3,116	3,028
(*c*) Degraded groves now used as farmland	1,343	—	2,214	2,109	3,098	1,912
(*d*) Original open farmland	944	1,177	1,425	1,757	—	—
(*e*) Compounds in farmland	614	1,605	2,162	2,084	2,771	—

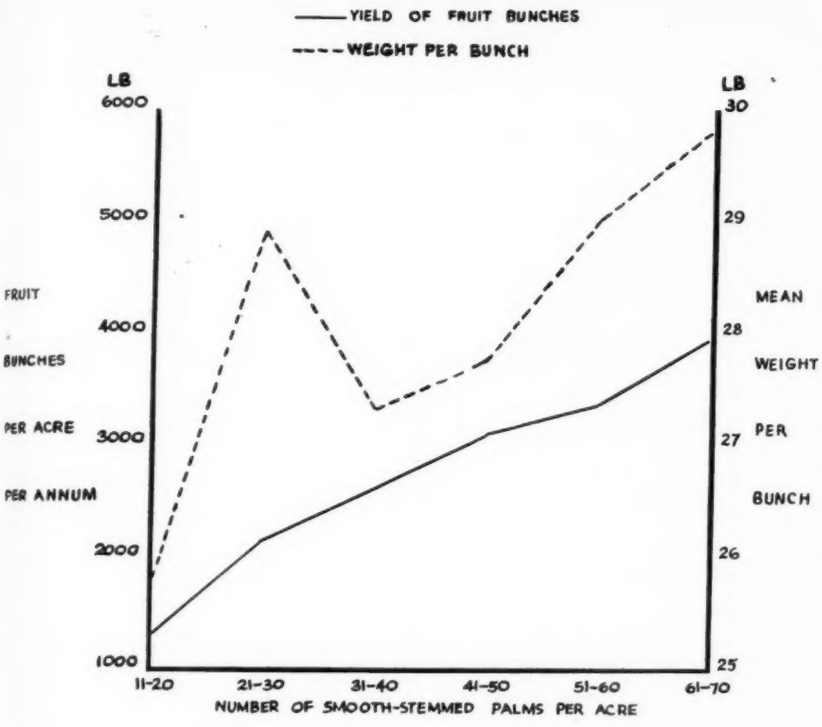

Fig. 3. The relation of density of smooth-stemmed palms to bunch weight and yield in a dense grove near Abak in Calabar Province

faced with the problems of nutrition. From what has already been said of the trials at Ekiadolor and Aba and of the apparently decreasing vigour of palms in the natural groves, it will be clear that palms planted in the main palm belt, where rainfall is adequate though not always well distributed, are likely to suffer severely from deficiencies of one or more mineral elements. This has, in fact, been the case and many plots which have been planted up over the last few decades are now small museums of deficiency symptoms of which those of potassium and magnesium are thought to be the most important. Experiments carried out by the institute at a number of centres have already shown the great importance of potash. Normal applications have in some cases nearly doubled yields and the good effect of the applications has been maintained for many years. Magnesium sulphate applications have been shown to cure orange frond disease[4] though it is too soon to see what the effects of this element will be on growth and yield. Other deficiencies are suspected and problems of diagnosis and cure are being tackled.

Shade

Another cultural problem, which will be of great importance in the palm-grove areas, is that of shade. The oil palm is a sun-loving plant and if it is denied sunlight it makes slow growth and is shy of fruiting. Its leaves, however, remain dark green and do not usually exhibit deficiency symptoms. A deceptive appearance of health is given, though vigour is obviously lacking. In the groves dark green seedlings will remain in this condition for years without making any noticeable growth. If trees around them die off, however, and light is admitted, they will shoot up and begin to bear. This is one of the reasons why deficiency symptoms are not so clearly seen in the groves as in replanted plots.

Food and palm products

Perhaps the most difficult cultural problem of grove improvement will be the fitting together of those two basic requirements of the palm belt, food for local consumption and palm products for consumption and export. It has already been seen that the sequence—compound palms, dense groves, degraded groves, farmland from degraded groves—is likely to lead to soil impoverishment. This will, of course, effect both food crop and palm-bunch production. It will be necessary, therefore, to find some way in which these crops can be grown together to their mutual advantage.

The solution

The problems of the groves will take many years to solve and will almost certainly involve a considerable change of outlook, and perhaps of social and economic organisation, on the part of the people of the palm belt. In discussing the problems involved, some indication has already been given of the lines of work the institute is pursuing. The testing of new methods will proceed hand in glove with fundamental studies of nutrient deficiencies and of the palm-belt soils. It is certain that no progress will be made with solving the palm belt's problems unless the results of these studies are translated into sound fertiliser programmes. Results so far obtained on planted areas have been so outstanding as to leave no doubt that the supply of mineral nutrients will be of the first importance. The effect of fertiliser dressings on the groves themselves has, however, yet to be seen and an area is being set aside for such a trial in the institute's groves at Abak. At the same time a further comprehensive fertiliser trial has been planned for a planted plot where deficiency symptoms are very pronounced.

The problem of shade will also require fundamental physiological investigation, but, in the meantime, it is being tackled in field experiments, both among plantation palms and in the groves. A small replanting trial started in one of the institute's fields at Umudike in Owerri Province has been showing interesting though not unexpected results. In replanted plots, the old palms were treated as follows: (1) all felled, (2) alternate north-south rows felled, (3) alternate east-west rows felled, (4) all leaves except the spear pruned annually, and (5) half the leaves pruned annually. Where all the old palms were felled the growth of the young seedlings has been outstanding, and where alternate east-west rows were felled growth has been good. Growth of seedlings under half-pruned palms has been very poor, while the

effect of the other two treatments has been intermediate. These preliminary results certainly confirm the retarding effect of shade and competition of old palms, but they suggest that the felling of broad avenues on an east-west line may be a favourable method of gradually replacing grove palms.

The problems of replacement have been taken a stage further in an experiment which has recently been laid down in a dense palm grove at the Government Farm at Obio-Akpa near Abak. The experiment takes the form of a 5 × 5 Latin square with 25 plots of half an acre each. One plot of each row and column was left in its original condition (*Treatment a*), while another (*Treatment b*) was completely replanted with seedlings of the *dura* × *tenera* cross which will give half *tenera* and half *dura* progeny. These treatments will be compared with methods of thinning and replanting, as follows:

Treatment c. The grove was thinned out in a purely practical manner, and the spaces left were filled by replanting with seedlings of the same cross as in the other treatments.

Treatment d. The grove was thinned out by reference to three years pretreatment yields and the spaces were again replanted with seedlings.

Treatment e. The grove was thinned out to approximately half plantation density, *i.e.* 30 palms per acre, and each plot was completely replanted at normal density.

In treatments *c* and *d* it is intended that the grove shall be maintained as such, but that the replacement of individual trees shall be controlled instead of being left to disease and chance. Treatments *b* and *e* are replanting treatments. All young palms are receiving fertiliser dressings and food-crop cultivation is being carried on, using a rotation normal for the district. Each column in the Latin square has been allotted to one of five farmers, who cultivate for food crops one row of plots each year, while the remaining four rows remain fallow.

These trials and the more fundamental work already described constitute only a beginning of the institute's work on palm-grove improvement. Survey work and the detailed examination of the institute's own groves is to continue and further experiments on grove replacement and maintenance are to be planned. In these the trial of avenue or twin-row methods of planting, with food-crop cultivation in between the rows, will amost certainly be included, while in all experiments fertilisers and the institute's selected seed will be used.

Fig. 4. Part of a typical palm grove in Eastern Nigeria looking from a sparse into a dense area

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Scotch Carts in Northern Rhodesia

Scotch carts of local manufacture have been produced for African farmers in the Eastern Province at Katete, Petauke and Chadiza Bomas during the last two years, and they are playing an increasingly important part in the agricultural development taking place, particularly in the Katete and Petauke areas.

There are two types of scotch cart, and both are subsidised by the Improved Farmers Fund and are sold at 50% of their cost. Both are of sturdy construction and have metal wheels, the one with a wooden frame and sides being sold at £12 10s. and the improved model with a metal frame and wooden sides being sold at £16.

Peasant farmers and improved farmers are the main buyers and for these farmers the scotch cart has become an essential piece of farm equipment, being used constantly for manuring, transporting seed and farm stores, and carrying the harvested crops to the co-operative buying depots. In order to help owners, trained workers from Petauke, Katete and Chadiza visit the villages and provide an 'after-sales' service, lubricating the wheel bearings and effecting necessary repairs to the wooden frame and sides. But with its very great advantages the advent of the scotch cart has brought its problems, for the iron wheels and the oxen which draw it do much damage to the roads in the province, and particularly to the Great East Road, and plans are having to be drawn up to make special scotch cart tracks alongside the Great East Road.

New Trends in Lucerne Seed Production in the United States

DR. C. DE FELLNER

THE use of lucerne as an outstanding fodder crop extends over all the world and quite a number of Commonwealth countries are participating in this development. Very good work is being done in this line in the U.S.A., and some of the new strains developed there during the last years show excellent promise, particularly in regions with warm climate and grown under irrigation. Since, however, information is rather dispersed, it might be of interest to review the actual position of lucerne-seed production in the U.S.A.

Lucerne is the most important green fodder crop in the United States, its acreage having increased from two million acres in 1900 to nineteen million acres in 1953. This increase has been made possible by the introduction and breeding of new strains able to withstand the cold winters of the north, where two-thirds of the lucerne acreage is situated. Only one-third of the seed required is produced in that area, however, and in this article Dr. De Fellner describes how the problem of seed supply has been overcome.

Favourable reception

Although the American farmer is just as careful in accepting new ideas or methods, crops or strains, as any other farmer in the world, he is still somewhat more inclined to accept the findings of research and to try something new. There are two reasons for this attitude—the first derives from his favourable experience in the introduction of new machinery. The advertising campaign and selling drive of the U.S. agricultural machinery industry has proved to his immense advantage. The second is the same good experience in following the advice of the U.S. Extension Service. Therefore, he is receptive to any recommendations for the use of novelties and everything by which he thinks to better his crops and improve his returns appeals to him.

It can be supposed that these are the main reasons for the extension of lucerne production in the U.S.A. and it is a remarkable achievement that in a country with the vast natural fodder resources of the U.S.A. the total acreage of a cultivated fodder crop should have developed to tenfold in 50 years. The acreage of under 2 million acres in 1900 has been extended to 19 million acres in 1953, and lucerne has become the most important green fodder crop of the country. Lucerne has definitely proved its usefulness in the greater part of the U.S.A., but undoubtedly the exacting work of breeders and research workers in building up a full range of ever-improving new varieties adapted to the different regions and soils of the country, has its due part in this success.

First varieties

We cannot enlarge here on the story of lucerne introduction and production in the U.S.A., except to assess the trends of the requirements to which breeders had to respond as this would give us a lead to the American strains. The first introduction occurred in the 1840's from Peru to California. Originating from a country with a warm climate, this strain could be grown only in the States where winters are mild. To extend lucerne growing in areas with winter temperatures German lucerne was introduced in 1857. This could withstand the cold winters of Minnesota and the middle West. One of these strains, named after its introducer, Wendelin *Grimm*, was recognised as a distinct variety in 1900, and later on the *Baltic* variety followed it in South Dakota. A long period of introduction and adaptation of Russian, Siberian, Turkestan and Indian strains followed, but undoubtedly Grimm has been, up to date, the winter hardiest of all varieties in general use. It has, however, been out-yielded in crop return, earliness and fineness of leaf texture by other strains, but its main defect was that it could not stand up to bacterial wilt.

The next task of the breeders has therefore been to build up wilt-resistant strains, combined with winter hardiness and good yield. By long-lasting, tenacious efforts they succeeded.

Further consideration by the breeder had to be given to the longevity of strain, as the farmer needed long rotation varieties which would enable him to reduce his considerable seed costs. Other specific problems arose, such as stem nematode resistance, adaptation of strains to soils and climate, especially drought resistance, raising of yields under irrigation, improving strains for the lucerne drying industry, and so on.

As the demand for new varieties grew from year to year the problem of the extension of seed production had to be met. Here unexpected difficulties had to be overcome. Although more than two-thirds of the total lucerne acreage is situated in the northern part of the U.S., only one-third of the seed has been produced in this area owing to the uncertain weather conditions changing year by year. Therefore, seed production in the north could not cover the huge requirements of the whole country.

Extent of lucerne production in the United States by varieties. (*Top*) **Buffalo alfalfa,** (*centre*) **Atlantic alfalfa and** (*bottom*) **Ranger alfalfa**

Seed-production programme

An answer to this challenge was found only after the fact was proved that one generation of any variety of lucerne seed can be produced away from its adapted home and retain its identity, if it is grown isolated from other lucerne strains. This meant that while the growing of lucerne for seed had been previously a by-product of forage production, it has now been developed to a specialised seed-production industry centred in the West. The United States with its natural advantages of different climates and soils could build up a programme which took stockseed of a successful variety to the best producing areas for increase of the new variety. The aims of this development have been:

1. To build up in a very short time seed supplies of new varieties from small quantities of stockseed which would be impossible in its own growing area with uncertain, and mostly low, yields.
2. To ensure constant and unvariable supplies of a new improved variety which could be developed only under unchangeable weather conditions and artificial water supply.
3. To discourage the excess production of strains with limited use which had a detrimental effect on the price structure of lucerne seed, as they tended to press the market in parts of the country where they were unadapted and where they could sell solely because of their low price.

This scheme could be built up only with the help of the National Foundation Seed Programme of the U.S.A., which arranged for the strict control of the strains to preserve their identity in order to minimise any genetical change that might occur if a second generation is grown from the original stockseed. It had to educate the seed grower to take into consideration the fact of cross pollination from neighbouring fields, to control volunteer plants from remaining seed or

from old plants of other varieties, and to watch the seed-producing capacity of individual plants within the variety.

Possible safeguards of the programme could be summarised as follows:

1. Limit the number of generations.
2. Isolation.
3. Control of crop rotation to prevent volunteers from previous seed crops.
4. Limiting the age of stand to cut the effects of natural selection.

Although there is no definite answer yet to the question for how many generations a variety would retain its outstanding qualities when its seed is produced in a different environment, the risks of unforeseen setbacks would be balanced by the enormous advantage of the constant production of a huge quantity of improved strains.

In view of these facts and due to the National Foundation Seed Programme of the U.S.A., seed production in the last years has been shifted, as stated before, from north and east to the west of the U.S.A., and lucerne-seed-growing areas are now concentrated in California, Arizona, Washington and other Western States, where most of the seed can be grown under irrigation. The result of this policy has been an unprecedented stability in supplies and a relatively uniform level of prices, provided that the weather conditions are normal and unlike those of the exceptional year of 1954, when crop failures all over Europe and in the U.S.A., extending to competitive fodder plants such as red clover and grasses, created extraordinary marketing conditions.

Production and costs

Lucerne-seed production has been built up in the years to be an industry. Production costs are high. The rental of honey bees for pollination is not less than $25 to $30 per acre, hand removal of weeds costs $12 to $15, irrigation costs might be $20 to $40, and pest control would be $10 or more above the normal working costs, depreciation, taxes, rents etc. On the other hand, yields are high and constant year after year. The average yield, for instance, for California Kern County has been 705 lb. against 139 lb. national average, but quite a number of seed producers have a return of 1,000 lb. or more up to records of 1,700 lb.

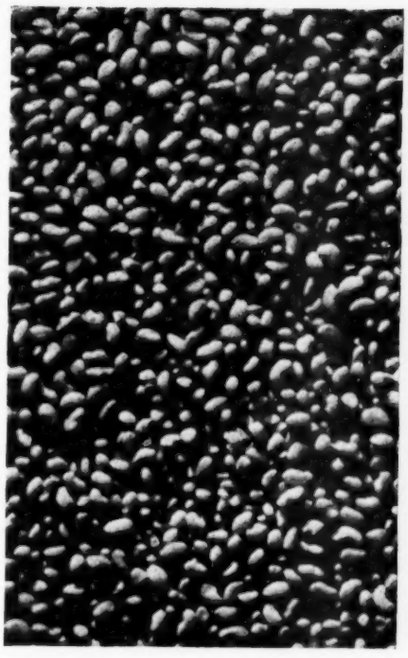
The increase in production of improved varieties has been quite spectacular. 407 million lb. of Certified Ranger in 1952 has been the largest quantity ever produced in the U.S., an increase of 250% on the amount produced in the previous year. The available quantity of Buffalo in 1952 was doubled compared with 1951. Atlantic increased from 150,000 lb. to 500,000 lb. in the same year. The latest figures show that the 1954 seed supplies of the four outstanding varieties—Atlantic, Buffalo, Narragansett and Ranger—amount to 38 million lb., *i.e.*, 87% of the total certified lucerne-seed area. The full success of the scheme is proved by the figures in Table 1.

Table 2 gives another insight into the success of the scheme.

No better proof is needed to show that in 1953 nearly 33 million lb. or 86.7% of the total seed production of the three outstanding varieties have been grown outside their adapted regions.

There is still a wide field for the extension of the scheme as only 37% of certified seed was used by farmers in 1954.

The total seed crop forecast for 1954 is 151 million lb., which is smaller than the record crop of 180 million lb. in 1952, but 10% higher than that of 1953. Out of this total, California produced 39% and their crop is 33% larger than in 1953. Taking into account the Government stocks, the total supplies for 1955 would be about 210 million lb., but of this a quite considerable quantity has to be deducted for export to cover shortages in other parts of the world,



Lucerne seed

TABLE 1

SUPPLIES OF CERTIFIED ATLANTIC, BUFFALO, NARRAGANSETT AND RANGER ALFALFA SEED FOR FORAGE PLANTINGS IN 1950 AND 1954

	1950 (*lb.*)	1954 (*lb.*)
Atlantic	6,204	1,880,230
Buffalo	632,927	8,834,324
Narragansett	0	148,896
Ranger	1,942,528	27,160,418

TABLE 2

RISE IN QUANTITY OF CERTIFIED VARIETIES

A SUMMARY OF THE PRODUCTION OF CERTIFIED ATLANTIC, BUFFALO AND RANGER ALFALFA SEED WITHIN AND OUTSIDE THEIR RESPECTIVE REGIONS OF ADAPTATION

Year	*Total U.S. production* (*lb.*)	*Production outside varieties' regions of adaptation* (*lb.*)	*Seed grown outside varieties' regions of adaptation* (%)
1934	31,000	1,000	3.4
1944	31,000	2,500	8.5
1947	757,000	271,500	35.8
1948	1,440,000	692,500	48.1
1949	2,581,500	1,325,000	51.3
1950	6,290,500	4,937,500	78.5
1951	19,175,000	14,834,500	77.4
1952	36,958,000	31,329,000	84.8
1953	37,875,000	32,819,000	86.7

especially in Europe, and it has to be kept in mind that the use of lucerne in the U.S. will probably be extended in 1955 owing to the shortage of other pasture seeds.

New strains

A short description of the best known new strains is as follows :

Atlantic

Variegated—selection from about 100 different U.S., European and Asian strains. Owing to this fact it is very variable and in consequence widely adapted. Flowers are deep purple to middle yellow, leaves from broad to narrow, light or dark green, plants erect and prostrate. It is a bad seeder in the north. Winter resistance medium—not greatly wilt resistant. Especially adapted for shallow, infertile soils, giving very high yields. In the U.S.A., it is recommended in the North-East and Atlantic Coastal States and in the central area east of the Mississippi.

Ranger

A multiple-strain variety, synthesised from selections of Cossack, Turkestan and Ladak. Its average yields are higher than those of the common varieties provided that it is left in the field longer than three years.

It has a wide variation in appearance—flowers variegated and occasionally yellow coloured, and plants from sprawling and recumbent to upright. Cold resistance is somewhat less than that of Grimm, Ladak or Cossack. Resistant to bacterial wilt, but less to Leaf Spot or Leaf Hopper Yellowing. A quickly recovering variety, better than Ladak or Cossack and equal to or better than Grimm. It is recommended for use in the Northern States.

Talent

A selection originating from Provence, it has been tested and improved since 1936 in South Oregon. Flowers light blue to reddish purple—leafy—well branching, stems strong but not coarse. Variegation in size and shape of leaves—long blooming. Develops a very strong root system and is a good seed producer. Winter hardiness normal. Vigorous, starts earlier and grows late in the autumn when other varieties are dormant. Recovery very fast. High yielder, and very persistent for long rotations and long stands. It is best in dry land under irrigation, resistant against Stem Nematode. Well adapted to South Oregon and North California.

Buffalo

A close bred selection of Kansas Common. Flowers bluish purple—upright with medium-sized stems. Cold resistance fairly good. Good resistance to bacterial wilt—less to Leaf and Stem diseases than Kansas Common. Recovery better than that of Kansas Common. Yields are higher than those of common varieties, especially when stands get older. Recommended for the central and south-eastern areas.

Narragansett

A mass selection. Flowers generally blue, but some variegation from white to greenish yellow. It has a much-branched root system and is a good seeder. It is winter hardy, vigorous and persistent. Recovery is very quick. Out-yields Ranger and Ladak in short rotations. Susceptible to wilt, but resistant to foliar diseases. Lightly resistant to Leaf Spot. Recommended in the north-east.

Lahontan

Purple flower, upright, earlier blooming than Ranger. Vigorous, quick in recovery and giving high yields. Immune against Stem Nematode and wilt-resistant as Ranger. Recommended for California and Nevada.

African

Blue-flowering, upright type with relatively broad leaves and heavy stems.

Non-dormant variety growing late in fall and early in spring. Recovery very rapid. Somewhat coarser in leaf than the Californian Common, and just as susceptible to wilt and foliar diseases. A short-lived variety for three to four years rotations. Recommended for California and south western parts of the United States.

Ladak

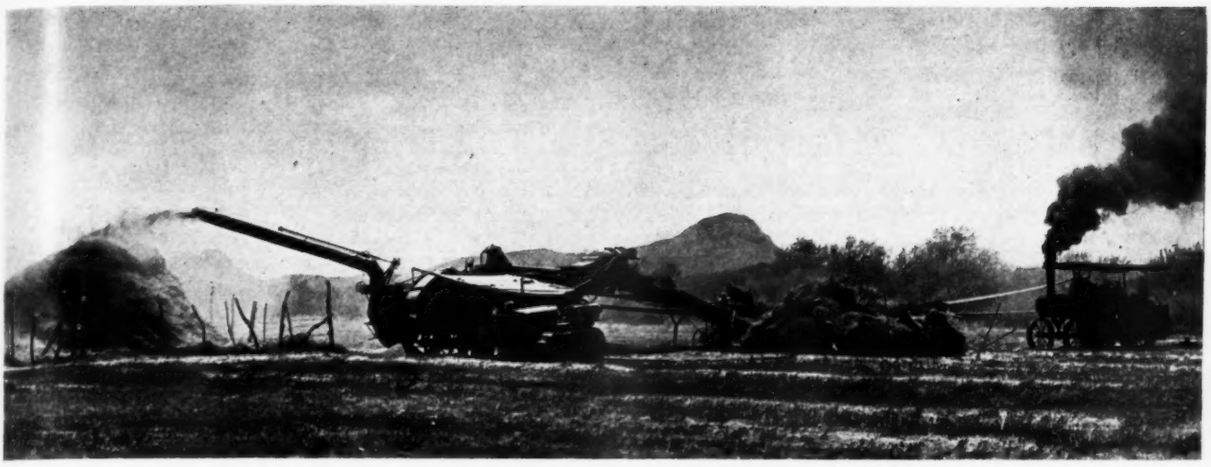
A variegated variety of North Indian origin. Flowers purple to yellow. Persistent, high yielding, very winter hardy, slow recovery, moderately resistant to wilt.

Williamsburg

Essentially blue flowered, moderate heavy stems, leaves of medium width. Developed from old Kansas stock. A long-lived variety with high yield, rapid recovery, resistant to Stem Rot. Recommended for Virginia and neighbouring States.

Some local strains are also showing very good promise, as for instance Washington, which is especially valuable with regard to winter hardiness as its country of origin has very cold, snowless winters with sharp northern winds. Kansas and Californian Common also show some promise. The

Combining lucerne direct from field in Arizona



Cut lucerne being fed into stationary thresher on a farm in Arizona

introduction of the French Du Puits lucerne in the U.S.A. has proved successful. Not only does it give very high yields compared with U.S. strains, but it is also widely adaptable.

Conclusion

Summing up, a scheme like this has the best chance of succeeding in a large, compact block of a country as the United States, with its varied climates and soils but homogeneous with regard to production system, costs, transport facilities etc., and it is therefore highly questionable how a similar venture would work out in the Commonwealth. However, there might be some possibilities in one or another part of it, where conditions are not too dissimilar, as for instance in Australia or India, but the approach would have to be very careful.

There is still not enough evidence to prove the complete safety of the leading principle of such a scheme; that the once growing away system can be used without its effect on the strain becoming detrimental in the long run. For example, it has not yet been established that drought resistance, which is of considerable importance for some parts of the Commonwealth, would not be affected by stocks grown under irrigation. Nevertheless, research is going on and the next decade could bring answers to these problems.

For producers outside the U.S.A. the main interest might be in the use of some of these American varieties after careful tests. The breeding work done in the U.S. has built up strains for special purposes and if the qualities thus developed could be retained under similar conditions in other countries, a source of constant supply would be available. This does not alter the fact that locally developed varieties might give better returns, but it seems doubtful if such achievements could be maintained in the long run without local breeding activities. And since the breeding of lucerne is a costly, long-term venture, it is questionable if—especially in view of the fact that the market for such varieties will necessarily be limited—this would be an economic proposition.

The fact is that strain mindedness seems to spread all over the world. Times are gone when farmers were just interested in the variety and did not care for the strain and its special advantages. Thanks to the breeder, farmers are now in the position to get an additional benefit when using the right strain; they have to take advantage of this fact or else they could not hold their own in this competitive world of ours.

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'Harvesting Alfalfa at Five Points' (*Seed World*, December 1954).

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Sir Harold Tempany

Sir Harold Tempany, who has been Editor of WORLD CROPS since its foundation in 1949, has retired in order to devote himself to his other interests which include the completion of a book on tropical agriculture. Mr. W. Leonard Hill, Chairman of Leonard Hill Limited, publishers of WORLD CROPS, has expressed his appreciation of Sir Harold's work for the journal and sent his best wishes, and those of the Staff of the Company, for a long and happy retirement.

Prof. Geoffrey Blackman, Sibthorpian Professor of Rural Economy, Dept. of Agriculture, Oxford University, continues as Advisory Editor of WORLD CROPS and Mr. J. Edward Thomas, Dip.Chem., has been appointed Associate Editor. Mr. Thomas was formerly Assistant to the Editor of the *Journal of the Science of Food and Agriculture* and has had practical agricultural experience in Australia.

Endrin

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DICYCLOPENTADIENE, a hydrocarbon found in small quantities in distillates from 'cracked' petroleum or coal tar, has proved to be a fruitful source of important pest-control chemicals. It is the starting point for aldrin and dieldrin, and it is also the raw material for the production of a new insecticide, endrin (formerly Compound 269).

The word 'endrin' is a coined, common name for the pure chemical which is the endo-endo isomer of 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4,5,8-dimethanonaphthalene. This compound is a stereo-isomer of dieldrin, which is the endo-exo isomer, and the small difference in structure is highly significant, since it endows endrin with greater versatility, as an insecticide, than that possessed by dieldrin. Thus, in addition to the range of insects killed by dieldrin, endrin will give control of many caterpillar and aphid pests.

At the present time, endrin is produced at the Shell plant at Denver, Colorado, U.S.A., although it is also to be made, with aldrin and dieldrin, at the new insecticide plant at the Pernis (Rotterdam) refinery of the Royal Dutch Shell Group. Production today, although valued in millions of dollars annually, is insufficient to meet world demands.

Properties and formulation

Endrin is soluble in aromatic hydrocarbons and ketones, sparingly soluble in alcohols and paraffin hydrocarbons and insoluble in water. Like aldrin and dieldrin, endrin is relatively non-volatile and is, therefore, persistent. Its vapour pressure is approximately 2×10^{-7} mm. at 25°C. It is unaffected by ordinary alkaline reagents, is compatible with most insecticides, fungicides and herbicides and presents, therefore, no special applicational problems.

The technical material marketed for formulation purposes contains 90% to 95% of endrin and is a pale buff, granular product, easily ground, and with a faint 'medicinal' smell.

In this report the author describes the properties of endrin, a new insecticide which is closely related chemically to aldrin and dieldrin. Previous references to endrin in WORLD CROPS *will be found on page 321, September 1952, and page 313, August 1954.*

Until early 1954, endrin was available commercially only as a 19.5% emulsible concentrate, a product which has been very widely used and which has been proved to possess excellent storage characteristics, both in temperate and in tropical climates. Technical endrin became generally available in March 1954 and can be formulated as dust concentrates (50% and 25%), as a water-dispersible powder (50%) and as low content (1% or 2%) dusts. The inert diluents used for the dry formulations can be calcium carbonate, talc, kaolin, pyrophyllite or special clays such as Attapulgite. When any of these materials, except calcium carbonate, is ground with endrin it is necessary to include in the mixture a small percentage of a stabiliser such as urea or hexamethylene tetramine which prevents any reaction between the endrin and the filler.[1] The finished product is then stable even under tropical storage conditions.

Spiny bollworm (*Earias insulana*) **larva in opened cotton boll** (× 2)

Commercial application

Endrin became available for field evaluation, outside the U.S.A., towards the end of 1952. In the past two years, hundreds of field experiments have been carried out in many countries. Sales demand developed very rapidly and hundreds of thousands of acres have now been treated, at rates varying from 4 oz. to 1 lb. of endrin per acre. These commercial applications have been made in more than 30 different countries, ranging from Formosa to the Belgian Congo and from Iraq to Peru and Venezuela. The versatility of the new insecticide has led, in particular, to its trial in cases where older materials had failed or given indifferent control, and some notable results have been achieved. While much work is still in progress, it is profitable to review the field results obtained to date and this is done below, under the headings of the various crops.

Cotton

Cotton presents a wide range of insect-control problems throughout the world and the versatility of endrin has already established its position as a leading cotton insecticide. A recent publication of the U.S. Department of Agriculture[2] states that in the view of many entomologists, endrin comes

closer to being an all-purpose cotton insecticide than any yet tested. In the 1954 Recommendations of the U.S. National Cotton Council,[3] endrin is stated to be effective as a spray against the boll-weevil (*Anthonomus grandis*), bollworm (*Heliothis armigera*), *Thrips tabaci*, fleahopper (*Psallus seriatus*), tarnished plant bug (*Lygus oblineatus*), salt-marsh caterpillar (*Estigmene acrea*), cabbage looper (*Trichoplusia ni*), cotton leaf perforator (*Bucculatrix thurberiella*) and leafworm (*Alabama argillacea*). Aphids, it is stated, 'did not build up after its widespread use in 1952-53.' However, endrin, in this report, is stated not to control the pink bollworm (*Pectinophora gossypiella*) or spider mites. The recommended dosage varies from 0.1 lb. per acre for fleahoppers and thrips to a maximum of 0.5 lb. for boll-weevil and leafworm.

In Central and South American cotton-growing countries endrin has been very successful and has given good control of the South American bollworm (*Sacadodes*) and the fall army-worm (*Laphygma frugiperda*) as well as the other common pests of the cotton plant. It is now widely used in commercial practice as a replacement for DDT-BHC or DDT-aldrin mixtures, and may be combined with parathion for mite control.

In Brazil, extensive trials[4] carried out over a two-year period, using endrin at 0.25 lb. per acre, applied as a low-volume spray at the rate of 4.2 imperial gal. (19 litres) per acre, gave extremely good control of cotton aphid (*Aphis gossypii*), leafworm (*Alabama argillacea*), bollworm (*Heliothis armigera*), thrips (*Thrips tabaci*) and Lygus bugs. Endrin at 0.5 lb. per acre, applied four times at intervals of about three weeks, also gave some control of pink bollworm (*Pectinophora gossypiella*).

A noteworthy result has been achieved in Iraq, where the spiny bollworm (*Earias insulana*) is the major pest of cotton. This bollworm is found in all cotton-growing countries in the Middle East, and also in Central Africa, India and Pakistan. In some countries, it is the chief factor limiting the extent to which cotton can be grown. Work carried out for a number of years in Iraq with arsenical compounds, with fluosilicates and with DDT and BHC was unsuccessful, but recent work by Walker and Haidari[5] has shown that endrin at 0.5 lb. per acre per application can give 'outstanding control,' significantly better than that of other insecticides used, including dieldrin; endrin is now in commercial use in Iraq. Similar good results in the control of *Earias* spp. have been reported from Israel and from India.

Work in India by the Indian Central Cotton Committee[6] has demonstrated that complete control of cotton jassid (*Empoasca devastans*) can be obtained with a spray containing 0.01% endrin. In this work, cotton aphis (*Aphis gossypii*) was completely controlled with endrin at 0.02%, results being as good as those achieved with 0.1% hexaethyl tetraphosphate (HEPT). Similar good results against cotton aphis have been reported from Israel.

Tobacco

An insecticide cannot be accepted for the treatment of tobacco until it has been shown that it does not cause taint, nor adversely affect the smoking quality of the leaf, nor leave undesirable residues on the foliage. In the U.S.A., endrin is fast becoming the preferred insecticide for tobacco since many trials, over a period of three years, have led to official acceptance of endrin not only because of its efficiency, but also because it does not taint the leaf nor affect it adversely in any other way. Endrin has received approval from the U.S. Department of Agriculture for the control of tobacco hornworm (*Protoparce sexta*), tobacco budworm (*Heliothis viriscens*), tobacco flea beetle (*Epitrex hirtipennis*) and grasshoppers. Control of aphis is also claimed. These insects represent all the major pests of tobacco foliage in the U.S.A., where there are about 1,650,000 acres planted to tobacco, of which 80% to 90% requires from two to four insecticide applications per season.

Work on tobacco pests in other countries is in progress. Notable results have been achieved in Australia, where the tobacco looper (*Plusia argentifera*) is a major pest. Control of this insect with other insecticides has not been good hitherto, but official approval for endrin is expected in 1955, following extremely successful trials using a concentration of 0.05%, applied as a spray at the rate of 35 to 40 gal. per acre (equal to approximately 0.2 lb. endrin per acre). In addition to the looper, other pests of Australian tobacco, controlled by endrin, are species of *Heliothis*, *Prodenia* and *Gnorimoschema*.

Sugar cane

Sugar cane suffers from the attack of a variety of insect pests. Thus the stem borer (*Diatraea saccharalis*) and the top-shoot borer (*Scirpophaga nivella*)

Young pine trees, Portugal, showing defoliation due to the processionary caterpillar (*Thaumetopoea pinivora*)

still cause widespread damage. There is evidence from Trinidad and from India that endrin will control these pests, but more work, especially on the application techniques to be used, requires to be carried out. On the other hand, trials in Pakistan in 1953 have shown[7] that endrin applied as a spray at the rate of 0.1 lb. per acre will give 100% control of pyrilla (*Purilla perpusilla*) and reports from Taiwan (Formosa)[8] indicate that the cane borer (*Chilo infuscatellus*), can be controlled with endrin used at the rate of 0.1 lb. per acre.

Rice

The world area of rice grown in paddy fields is about 200 million acres; 90% is grown in Asia, eastwards from Pakistan. An unknown but large proportion of this area is infested with stem borers, which cause a loss of crop said to be rarely less than 10% and sometimes as great as 60%.

There are a number of borers attacking rice, of which the most important belong to the genera *Schoenobius*, *Scirpophaga*, *Chilo* and *Proceras*. These pests are small moths, the eggs of which are laid on the stems of the young rice. In due course, the larvae bore into the stem and spend most of their life feeding on the tissues and so injuring the plant that little or no crop is produced. The visual effect is a dwarfed stem, bearing a seedless head (' white-head ').

The life history of certain stem borers is insufficiently known but it seems probable that the first instar larvae, and perhaps later stages, leave the stem and migrate to other plants. The correct time of application of endrin is the period of egg laying, which is usually two to five weeks after transplanting. The long persistence of the insecticide is, of course, advantageous, since those larvae not killed before entry into the stem are killed at the later, migration stage.

The application rate of endrin has not yet been fully established, in spite of much field work carried out in Japan, Taiwan and the Philippines. Complete control of borers over a long period has been obtained with endrin used at 5 oz. per acre (as the diluted emulsible concentrate) but there is evidence that 1.3 oz. per acre can give effective control if the timing of the application is correct.

Rice stem borer control in the Philippines. Unsprayed rice. Note the ' white-heads ' which are erect because they are light and empty

In Venezuela, the fall army-worm (*Laphygma frugiperda*) attacks young rice at a very early stage and can cause almost a complete loss of crop. Endrin is now widely used at 0.3 lb. per acre, applied as the emulsible concentrate.

Coffee

Trials were carried out in 1953 in the Belgian Congo to compare endrin with other insecticides for the control of the coffee-berry borer (*Stephanoderes hampei*) and pyrale (*Dichocrocis* sp.) both of which cause widespread damage. The results achieved, at 0.5 lb. endrin per acre, were so outstanding that large areas are now being treated commercially.

Cork oak and forest trees

Ground equipment and aircraft have been used for the past two years in Portugal to spray groves of cork oak and also forest trees with endrin. The insect pests involved in this work are the lackey moth (*Malacosoma neustria*), the gypsy moth (*Lymantria dispar*), the brown-tail moth (*Euproctis chrysorrhoea*), the oak-leaf roller moth (*Tortrix viridana*) and the processionary caterpillar (*Thaumetopoea pinivora*). All these pests can cause partial or total defoliation of the tree. Endrin is used at the rate of 1.12 oz. (0.07 lb.) per acre, applied as a solution in gas-oil, of which 3.3 gal. (15 litres) are sprayed per acre. The time of application is about 14 days before the eggs hatch (gypsy moth) and 100% control has been obtained for a period of two months. In the case of the oak-leaf roller moth, two applications are made, the first in early March and the second during the first week of May. Spraying against the processionary caterpillar is carried out in the period September-December, when the first to fourth instar larvae are active.[9]

Similar results to those reported from Portugal have been obtained in the U.S.A., where complete extermination of the American brown-tail moth (*Nygmia phaeorrhoea*) and gypsy moth (*Porthetria dispar*) has been obtained using 0.5 lb. endrin in 1 gal. of kerosene per acre.

Orchard crops

During the past decade, the deciduous fruit grower in Western Europe has been able to use the newer, organic insecticides as a spring wash for the control of the over-wintering or spring insect pests found in the orchard, either to supplement or in some cases to replace the traditional winter wash treatments. In this connection, DDT or BHC, used separately, are insufficiently versatile, and a mixture of the two insecticides may be employed to control the complex of insects normally found on the tree.

Trials[10] over a two-year period have shown, conclusively, that endrin used at the very low concentration of 0.026% gives results fully equal to or

Rice stem borer control in the Philippines. Rice sprayed with endrin. Note the heavy, drooping heads of grain

better than those achieved with a DDT-BHC mixture. The pests controlled are aphis (*Anuraphis roseus*), apple sucker (*Psylla mali*) and winter moth caterpillar (*Operophtera brumata*); apple sawfly (*Hoplocampa testudinea*) is fully controlled with a separate endrin treatment at 0.013% applied in May at the 'petal-fall' stage with the post-blossom lime-sulphur wash. In all pre-blossom treatments, the insecticide is combined with the normal lime-sulphur spray. Further work is now in hand to determine the value of 'omnibus' spring washes, combining endrin with fungicides and acaricides.

Other crops

The versatility of endrin has led to its use in trials on a wide variety of crops not mentioned above. Thus, the army-worm (*Laphygma frugiperda*) attacking maize in Venezuela is now controlled on a large scale by the use of endrin at 0.3 lb. per acre. The same army-worm, in Carolina and Virginia, U.S.A., is controlled[11, 12] on sweet corn by the use of 0.25 lb. endrin per acre. 'Almost perfect control' is reported from Virginia. A second army-worm (*Laphygma exempta*) can be effectively controlled[13] in Kenya by the application of endrin at the rate of 0.08 lb. to 0.15 lb. per acre, with a 100% reduction in population, after three days, at the higher dosage. In South Africa, *Laphygma exempta* has been successfully controlled[14] on grassland, using 0.08 lb. (1.3 oz.) of endrin per acre. In this case, an emulsible concentrate was diluted with water and sprayed at the rate of 15 gal. per acre. Reports have been received from Western Australia showing that the red-legged earth mite (*Halotydaeus destructor*) can be controlled with endrin at 0.1 lb. per acre. 'Outstanding control' of the cranberry fruitworm (*Mineola vaccinii*), a serious pest in U.S.A. cranberry-growing areas, has been reported,[15] using endrin at 0.2 lb. per acre. The U.S. Department of Agriculture, in February 1954, approved the use of endrin for the control of the sugar-beet webworm (*Loxostege sticticalis*); an application of 0.3 lb to 0.5 lb. of endrin per acre is recommended. The results of work with this pest were reported in 1952,[16] when endrin was known as 'Compound 269.' An important result is described[17] by workers in North Carolina, where the southern corn-stalk borer (*Diatraea crambidoides*) is one of the most destructive pests of maize. Endrin, at 0.12 lb. per acre. is reported as giving, from the standpoint of plant development 'the most satisfactory treatment'; almost complete control was obtained.

Mammalian toxicity

As is now necessary with any new insecticide, a substantial volume of work has been carried out to show whether endrin can be used on the farm with safety and, if so, under what conditions. The acute oral toxicity of endrin to small laboratory animals is greater than that of aldrin or dieldrin, the LD-50 to male rats being, approximately, 35 mg./kg. and to female rats about one-half of this figure. A diet containing 5 parts per million of endrin fed to rats over a two-year period did not increase mortality or decrease survival time; even 25 p.p.m. of endrin in the diet proved to be only moderately toxic. Dogs maintained on diets containing 3 p.p.m. endrin showed no abnormal signs after three months. Absorption by the intact skin does not occur to any greater extent or at any greater rate with endrin than with aldrin or dieldrin.

The chlorinated hydrocarbon insecticides as a class have proved in practice to be remarkably safe to handle, both in the factory and in the field, in spite of laboratory indications to the contrary. Their toxicity is altogether of a lower order than that exhibited by the older anticholinesterase or phosphate insecticides, or by arsenic compounds. Nevertheless, sensible precautions must be observed with endrin. When concentrated formulations are being handled, gloves and other protective clothing are indicated and contamination of skin and ordinary clothes must be avoided. The dosage rate normally employed per acre is so low that in actual spraying or dusting the hazard to the operator is probably no greater than in the case of other chlorinated hydrocarbon insecticides. Again, however, gross contamination by and inhalation of dilute sprays or dusts must be avoided, as with similar insecticides, especially if the work in the field is prolonged.

The position today is that the fast-growing use of endrin, on many crops in many countries, has already proved that this new material is safe to use provided commonsense precautions are taken. It is, of course, this wide-spread experience under a great variety of conditions which finally determines the real hazard, if any, attached to the field use of a new plant protective chemical.

Residues

The question of residues on crops treated with endrin has been studied primarily in the U.S.A. and appropriate analytical methods are being worked out. No official tolerance has been established to date; the usual

A 'Piper Cub' of the Hind Flying Club, Lucknow, spraying endrin at 0.18 lb. per acre for the control of sugar-cane pyrilla (*Purilla perpusilla*) in Bhopal, India

figure adopted at first is 'less than 0.1 p.p.m.,' but the safe level, in the case of endrin, may be considerably higher. At the present time it is recommended that application to vegetables should not be made later than six weeks before harvesting. For many crops (*e.g.* rice and maize) residue difficulties with endrin have not arisen. No tainting has been noted, either with, for example, cabbages sprayed with endrin or with potatoes grown in endrin-treated soil.

Conclusion

The present paper must be regarded as an interim survey of the uses which have been developed for endrin. At the present time much world-wide work is in progress and more specific accounts of different fields of use of the new material will be available within the next year. There is now no doubt that endrin forms, with aldrin and dieldrin, a formidable trio of rivals to the older synthetic insecticides, making practicable the economic and effective control of crop pests on a scale and to an extent not previously possible.

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Pre-Emergence Weedkiller

Sprex, an entirely new type of pre-emergence weedkiller, has been put on the market by Shell Chemicals Ltd. Based on a non-persistent oil fortified with pentachlorphenol (PCP), *Sprex* is applied by means of conventional spraying machines, high or low volume, and is non-poisonous when diluted for use. It may be applied to any crop which germinates slowly and by using a special technique to others which germinate more quickly, though its principal use is likely to be in sugar beet, fodder beet and mangolds. On these, *Sprex* should be applied from one to three days before the crop is expected to emerge.

In the case of beet where natural seed has been drilled (*i.e.* not rubbed or segmented), application has been successfully delayed until the first plants are emerging, but spraying must then be carried out immediately. This late application, although giving very good results when carried out correctly, is so dependent on correct timing that it is suitable only for farmers with their own spraying equipment. If more than one emerged plant can be found per 100 in. of row, it is too late to spray.

If the seed bed can be prepared in advance of sowing, and the weeds allowed to germinate, *Sprex* may be applied to other vegetable crops shortly after sowing, and this technique is recommended for crops which normally germinate fairly quickly. The soil must be disturbed as little as possible during drilling operations.

The weedkiller is applied at 3 to 5 gal. in 30 to 100 gal. of water per acre. The lower volume may be used for weeds with large cotyledons, like charlock, but the higher rate of application must be used on weeds with thin erect cotyledons, like knotgrass. The 3-gal. rate is sufficient for light sandy soils and susceptible weeds, such as penny-cress, charlock and fat hen, but 5 gal. per acre are needed on soils with high organic content, like those of the fen, or if a high infestation of knotgrass or persicaria is expected.

It is claimed that *Sprex* will give an effective control of all common annual weeds, but perennial weeds are only scorched and recover rapidly, so that the material is not recommended for the control of docks and thistles.

Emergence in a weed-free seed bed is of obvious advantage to the crop, which gets away strongly in the absence of competition. Under these conditions the normal first horse-hoeing can be omitted and if, later, soil conditions demand cultivation hoeing is simplified by the increased visibility of the crop rows.

Agronomic Value and Production of TVA Fertilisers

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One of the duties of the Tennessee Valley Authority is to carry out a research programme designed to discover and produce cheaper and more effective fertilisers and to test these fertilisers in practical use. This work has been mentioned in Dr. Harry Curtis' articles on the Authority in previous issues (see* WORLD CROPS, *2, 55, 1950, and 5, 105, 1953). The following article discusses the response of crops to the phosphorus component of some of the principal fertilisers developed or investigated by the Authority.

THE search for new, better and lower-cost fertilisers has been an important part of the world-wide programme to increase food supply. One of the most intensive fertiliser research programmes during the past 20 years has been conducted by the Tennessee Valley Authority. Fertiliser research here is somewhat unique in that the activities include fundamental measurements of the physical and chemical properties of possible fertiliser compounds, laboratory and pilot-plant studies of production processes, greenhouse and field testing of new or improved materials, and the large-scale production of selected fertiliser products.

Chemical and chemical engineering phases of fertiliser research are conducted at Wilson Dam, Alabama. Products of special interest and need are produced in large-scale TVA-operated plants. This large-scale production permits the complete study of problems encountered in new processing procedures. The TVA manufacturing plants serve as models and demonstrations for industrial organisations interested in the processes, and the large quantities of fertilisers produced make possible introduction and evaluation of the products under practical farm situations.

The agronomic evaluation of TVA products is made in co-operation with state agricultural experiment stations. TVA fertilisers are made available for testing to all agricultural experiment stations in the United States without charge. But the need for special and intensive experiments for the complete evaluation of each new fertiliser material has resulted in TVA's providing financial assistance to 11 state experiment stations* to offset part of the costs of conducting the experiments. This paper is primarily a summary of information obtained on the response of crops to the phosphorus component of some of the principal fertilisers developed or investigated by TVA. The yield data reported were obtained in field tests in 11 or more States. Although the experiments involved varied appreciably, the phosphate in each fertiliser was compared in each test with equal amounts of phosphate supplied in concentrated superphosphate. To place the crop data on a comparative basis, the relative yield from treatment with a given fertiliser has been calculated for each test on the basis of the yield with equal amounts of phosphate supplied by concentrated superphosphate being given an arbitrary relative yield value of 100.

Concentrated superphosphate and ammonium nitrate are produced by TVA on a large scale, but these products are so widely used that they are not discussed in this paper.

Fused tricalcium phosphate

Fused tricalcium phosphate is produced by heating rock phosphate and silica to about 1,450°C. in a shaft furnace by means of oil or gas fuel. The water vapour necessary to expedite the defluorination of the fused phosphate is formed in the combustion of the fuel used. The molten mass from the furnace is rapidly cooled and granulated in jets of water. The product contains less than 0.4% fluorine and about 29% total P_2O_5. It contains practically no water-soluble P_2O_5, but about 20% to 24% of P_2O_5 in the finely ground product is soluble in neutral ammonium citrate solution. The material has excellent handling qualities. It can be stored in bulk in the open without either its physical or chemical properties being adversely affected. Near maximum crop response is obtained from the product when it is ground to pass a 40-mesh screen.

Considerable trouble was encountered in developing a furnace lining that would resist corrosion during large-scale production operations. After many trials a graphite lining was developed and used in a continuous operation for 18 months without evidence of serious corrosion having taken place. A copper-lined furnace has also been effective in resisting corrosion. After 15 years of research, production, and field testing, the data on fused tricalcium phosphate are now considered fairly complete and plant production was discontinued in June 1954. About 100 tons of the product is stock-piled for future research purposes.

A summary of a large number of field experiments indicates that fused tricalcium phosphate is not a satisfactory fertiliser on alkaline soils. An average of 20 experiments gives yield increases with fused tricalcium phos-

*These co-operating agricultural experiment stations are in Alabama, Colorado, Georgia, Iowa, Kentucky, Mississippi, New York, North Carolina, Tennessee, Virginia and Washington.

The TVA chemical engineering building at Wilson Dam, Alabama, where fertiliser research is conducted. The nitric acid plant and other fertiliser production facilities are visible in the background

phate on alkaline soils only 38% as great as yield increases from concentrated superphosphate. Liming acid soils apparently slightly decreases the relative efficiency of fused tricalcium phosphate. In 36 field experiments having a lime variable, the relative yield values for fused tricalcium phosphate compared with concentrated superphosphate was 98 on the limed areas and 101 on the unlimed areas.

The yields with various crops have been determined in over 400 experiments in which phosphorus treatments gave significant yield increases in humid-region conditions on acid to neutral soils. The number of experiments reported and the relative yields of a number of crops growing on soils treated with minus 40-mesh fused tricalcium phosphate compared with yields from treatment with concentrated superphosphate rated as 100 are reported in Table 1. In all experiments the fused product was applied on the basis of total rather than citrate-soluble P_2O_5.

TABLE 1

RELATIVE YIELDS OF DIFFERENT CROPS GROWING ON SOILS TREATED WITH FUSED TRICALCIUM PHOSPHATE COMPARED WITH YIELDS FROM TREATMENT WITH CONCENTRATED SUPERPHOSPHATE RATED AS 100

Crop	*No. of experiments*	*Relative yield*
Soya beans (beans)	4	106
Alfalfa and sericea	42	101
Pasture	35	101
Small grain (grain)	72	100
Red clover ..	17	100
Vetch and crimson clover	38	99
Maize	60	97
Soya beans (hay) ..	6	97
Small grains (forage)	15	96
Sudan grass (hay) ..	6	96
Cotton	69	95
Lespedeza (hay) ..	5	93
Vegetable crops ..	16	88

The results indicate that fused tricalcium phosphate is a fully satisfactory phosphate fertiliser for most hay and forage crops and is moderately satisfactory for row crops having long growing periods. The product is unsatisfactory for vegetable crops which have limited root systems and a short growing period.

Calcium metaphosphate

Calcium metaphosphate is produced by the reaction of P_2O_5 gas with rock phosphate at high temperatures. The product contains 60% to 64% total P_2O_5 and about 18% calcium. When finely ground, nearly all of the P_2O_5 is soluble in neutral ammonium citrate solution, but it is not appreciably soluble in water. Calcium metaphosphate normally shipped from TVA is ground to pass a 10-mesh screen, and about one-fourth or more of the material will pass through an 80-mesh screen. About 5% of ground limestone is added as a conditioner to prevent caking. The product has satisfactory handling and storage qualities. It can be handled in bulk or in bags and does not cake or agglomerate. Calcium metaphosphate was produced in small experimental amounts in 1935. Large-scale production has continued since 1937. By July 1, 1953, over a million tons had been distributed for domestic use in the United States. There were some overseas shipments during the last war, particularly to England.

Calcium metaphosphate treatments have increased crop yields to about the same degree as concentrated superphosphate in a large number of tests with a variety of crops on acid to neutral soils. Some of the results obtained are summarised in Table 2.

TABLE 2

RELATIVE YIELDS OF CROPS GROWING ON SOILS TREATED WITH CALCIUM METAPHOSPHATE COMPARED WITH YIELDS FROM TREATMENT WITH CONCENTRATED SUPERPHOSPHATE RATED AS 100

Crop	*No. of experiments*	*Relative yield*
Maize	151	100
Cotton	233	99
Hay and pasture ..	265	99
Small grain ..	293	97
Vegetable crops ..	44	95

The relative value of calcium metaphosphate as a fertiliser for alkaline soils has not been fully determined. Generally, phosphate uptake and crop yields taken within two or three months after date of calcium metaphosphate application have been inferior to such data obtained from simultaneous treatments with superphosphate. Also, tests with radioactive phosphorus compounded into different fertilisers have demonstrated that phosphorus is generally less available from calcium metaphosphate than from superphosphate the first season following application. However, residual benefits from most phosphate fertilisers are generally

greater on alkaline soils than on acid soils. When yields have been measured the second and third years following calcium metaphosphate application, crop responses have been generally as good as with superphosphate. Probably calcium metaphosphate will have to be used under more restricted conditions on alkaline than on acid soils. Fertiliser placement and moisture relations may be important factors affecting availability under these conditions. Where immediate phosphate availability is not important, or where the fertiliser is applied several weeks before planting, calcium metaphosphate has generally given satisfactory results on alkaline soils.

Potassium metaphosphate

Potassium metaphosphate has been produced only under small-scale and pilot-plant experimental conditions. This production was confined to a few years around 1940. Two production processes were developed by TVA. In one process, P_2O_5 vapour from burning phosphorus reacts with potassium chloride forming molten potassium metaphosphate. In the other process, phosphoric acid is mixed with potassium chloride and the mixture is fused and dehydrated in a fuel-fired furnace to form potassium metaphosphate. Hydrochloric acid is a by-product in both cases. The product contained about 55% P_2O_5 and 35% K_2O. Potassium metaphosphate is moderately soluble in water and hydrolyses readily in the soil providing phosphate and potassium available to plants.

Greenhouse and field tests with both acid and alkaline soils have shown potassium metaphosphate to be a fully satisfactory fertiliser. An average of 46 field tests on acid soils gave a relative yield of 101 for phosphate in potassium metaphosphate compared with 100 for superphosphate. Tests in Idaho and Utah on calcareous soils showed plant responses to the phosphate in potassium metaphosphate was as great as to that in superphosphate.

Processes for the production of potassium metaphosphate have not as yet been developed to the point where they are economically attractive.

Nitric phosphates

Fertilisers produced by the reaction of nitric acid, or mixtures of nitric acid with sulphuric or phosphoric acid, on rock phosphate have been used more extensively in Europe than in the United States. However, TVA has produced nitric phosphate fertilisers experimentally by six variations of the general process (procedures reviewed by Curtis in WORLD CROPS, **5**, 107, 1953) and the products have been widely tested under a variety of soil and cropping conditions. Fertilisers having such analyses (analyses expressed as per cent. nitrogen, per cent. available P_2O_5, and per cent. water-soluble K_2O, respectively) as 12-32-0, 17-22-0, 6-18-0, 11-11-11, 12-12-12, and 14-14-14 have been produced. When processes are used which do not include sulphuric acid or sulphate of potash, the product is often ammoniated until water-soluble phosphate is almost eliminated in order to convert the calcium nitrate produced in the initial reactions to ammonium nitrate. The process involving precipitation of calcium by treatment with carbon dioxide and ammonia gives such a low-water-soluble phosphate product.

Field and greenhouse tests indicate that the nitric phosphate materials are as satisfactory as comparable commercial-type mixtures for most crops. Possibly a third of the phosphate in nitric phosphate fertilisers should be kept in a water-soluble form in order for these materials to be fully satisfactory on vegetable crops and maize. No relationship has been found between water solubility of phosphate in nitric phosphate materials and yield increases of cotton, wheat and oats.

Fertilisers from leached-zone ores

High-grade Florida phosphate deposits used for fertilisers are overlain by low-grade phosphate ores containing 10% to 20% P_2O_5. Through long periods of weathering, this overburden material has been leached of part of the phosphate and much of the calcium and fluorine. The phosphate remaining occurs principally as aluminium phosphate minerals such as wavellite and pseudo-wavellite. In commercial operations, these leached-zone ores are scraped away and discarded. In 1952, an estimated 14 million tons of such ores were discarded. A significant saving in an important material resource would be made if economic processes could be found to utilise these ores in fertiliser manufacture. TVA has produced several fertilisers by extracting leached-zone ores with nitric or a mixture of nitric and sulphuric acids. Approximately the same quantities of acid are needed per unit of P_2O_5 as in high-grade ores. The resulting solutions are ammoniated.

A Tennessee Agricultural Experiment Station test plot for determining the response of wheat to TVA fertiliser

Muriate of potash may be added to the ammoniated slurry. Fertilisers of such grades as 20-20-0, 11-22-11, and 15-15-15 have been produced. The process also provides for the recovery of uranium in the ores.

Field and greenhouse tests in eight states indicate that the high-alumina fertilisers produced from leached-zone ores can be fully satisfactory under general field conditions. As in the case of ordinary nitric phosphate fertilisers, the products from leached-zone ores should have a portion of the phosphate in a water-soluble form for some crops.

Diammonium phosphate

TVA first produced diammonium phosphate by the reaction of ammonia with electric-furnace phosphoric acid. The almost pure product contained 21% nitrogen and 54% P_2O_5. More recently, a satisfactory procedure has been developed for producing diammonium phosphate from wet-process acid. It has been necessary to add clay or other agents to produce a good-handling, agglomerated product that will remain free-flowing after protracted storage. The agglomerated product expected to be produced by TVA on a moderately large scale will probably contain about 18% to 20% nitrogen and 47% to 50% P_2O_5. The phosphate is about 90% water soluble. High-grade fertilisers have been produced by compounding diammonium phosphate with potassium chloride and ammonium nitrate. Grades produced on an experimental scale have included 25-25-0, 18-18-18, 11-22-22 and 10-30-20.

Field and greenhouse tests have shown diammonium phosphate to be a fully satisfactory fertiliser, giving similar crop yield increases to superphosphate where phosphorus was the the only deficient nutrient.

New materials

Additional phosphate-containing fertilisers are being investigated by TVA. At present, several compounds have been produced on a small scale by the reaction of P_2O_5 with ammonia and water. These products contain 14% to 18% nitrogen and 70% to 78% P_2O_5 and vary in degree of water solubility. Greenhouse evaluation tests on these are incomplete.

Several fused potassium-calcium phosphates have been produced on an experimental basis by heating mixtures of concentrated superphosphate, phosphoric acid, and muriate of potash. These products are high in nutrient content and vary greatly in solubility. The phosphate content of products under investigation ranges from 20% to 50%, and the potash content varies from 20% to 45%. Possibly such products may be advantageous on sandy soils where potassium leaching is a problem or in fertilising crops where luxury consumption of potassium is excessive. Initial tests have not been completed on these products.

New research trends

Fertiliser research in the Tennessee Valley Authority is being modified to place greater emphasis on the improvement of current manufacturing processes and on nitrogen and potassium compounds. New procedures for ammoniating and granulating mixed fertilisers in continuous processes have been recently developed and are being widely adopted by industry. There is also being effected in TVA a closer co-ordination of research on processes and new materials with agricultural research on reactions of fertilisers with soils and on the utilisation of fertiliser nutrients by plants. This change in emphasis has resulted in part from a conviction that savings in fertiliser costs from new materials or new processes will probably be small in comparison with savings from improved agricultural use practices.

Granadin Seed Dressing

Increasing quantities of cereals are now being dressed with dual-action seed dressings and, with a reduction in price of these combined dressings, more and more farmers are availing themselves of the insurance that they offer against losses caused by wireworm and disease attack.

Up to the present time, the only combined seed dressings available on the market in this country have been based on gamma BHC. Since the discovery of the insecticidal properties of BHC in 1942, however, other more potent insecticides for the control of wireworms have been discovered. Important amongst these discoveries is the hydrocarbon insecticide, aldrin, which in addition to its increased insecticidal properties is entirely free from any risk of causing taint, even when used at rates far higher than those required for efficient insect control. Although aldrin-based seed dressings are now being extensively used in the U.S.A. and Canada, *Granadin* is the first combined dressing of this type available in Britain.

Information on the action of insecticidal seed dressings is far from complete. So far as the older types of insecticides are concerned it is generally agreed that they provide protection for the young seedling by exerting a repellant action on the wireworm without actually reducing the total wireworm population of the soil. Preliminary results from field trials of *Granadin*, however, are stated to have shown that in addition to the repellant action, the total wireworm population of the soil is also reduced.

Investigations are also being conducted on the effects of *Granadin* on the germination of stored seed, and results obtained indicate that wheat treated with *Granadin* may be stored for some considerable time without any adverse effects being incurred so far as germination is concerned. *Granadin*, which is available in 1 lb. and 7 lb. tins and 56 lb. drums, is used at the rate of 2 oz. per bushel of seed, and gives protection against both wireworms and seed-borne diseases for a cost of no more than 4s. per acre.

To Authors and Readers

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Sugar Production in Indonesia

JOHN GRINDROD, B.A.(COM.)

In this article the reconstruction of the sugar industry in Indonesia after the war is described.

AS with so many of Indonesia's products, the story of Indonesian sugar is one of struggle to regain something of the output lost through the devastation of the second world war and the internal strife that followed it.

Although throughout the world the years 1928, 1929 and 1930 were not, industrially, prosperous years, they happen to be years of high production for the Indonesian sugar industry. Output was then running at 2,923.6 million kg., 2,871 million kg. and 2,915.9 million kg. respectively.

The slump in Indonesian sugar production came during the years 1934, 1935 and 1936, when, of the 178 mills existing at the beginning of the period, there remained only 37 in operation at the end of 1936. Production fell to 636.1 million kg. in 1934 and 509.7 million kg. in 1935, but rose slightly to 574.7 million kg. in 1936. Output subsequently improved until the Japanese invasion.

In 1940, there were 100 sugar-cane estates in Indonesia, 96 of which each had a factory of its own, though only 85 of these were actually operating. The quantity of crystal sugar processed in these mills during that year was 1,587.4 million kg., the cane being obtained from some 90,800 hectares of plantations. This total quantity of sugar processed also included smallholders' cane milled for the production of crystal sugar.

During the Japanese occupation most of the 85 factories were either demolished or closed down. What few remained were nearly all destroyed as a result of the Indonesian-Dutch armed conflict in 1947 and 1948.

Reconstruction

Not until 1949 was any sort of reconstruction work possible, and then it began only very slowly. By 1950, production of crystal sugar amounted to 277.1 million kg., and this figure was increased to 426.3 million kg. in 1951. By 1952, some 450 million kg. of crystal sugar were being processed in 46 mills. This represented 29% of Indonesian pre-war production or 15% of the figure for 1929. These figures do not include smallholders' sugar not processed at the factories.

According to Government sources, production during the next few years is estimated as shown in Table 1.

Figures compiled by the Central Bureau of Statistics show that estate production of sugar in 1953 was, in fact, 619 million kg.

Transporting sugar cane by miniature railway to the factory

Sugar varieties

Several kinds of sugar-producing plants are grown in Indonesia. Of these, sugar cane is the most important and from this factory or crystal sugar, known locally as ' gula pasir,' is processed by the mills, normally for export. In certain districts the Indonesians obtain such products as ' gula merah ' (red sugar), ' gula mangkok ' (cup sugar) and ' gula tandjung ' (fragrant sugar) from the sugar cane. These varieties are demanded chiefly in Java, where most of the smallholders' sugar cane is grown. The ' aren ' (*Arenga pinnata* merr) and coconut palm (*Cocos nucifera*) are the sources of what is known as ' gula djawa ' or Javanese sugar. This is a reddish-brown sugar, processed mainly for internal consumption and grown particularly on the islands outside Java that have very little cane sugar.

In addition to crystal sugar, the mills produce ' gula tetes ' or molasses from the residue of the sugar cane. Molasses production amounts to from 12% to 20% of the crystal sugar obtained, varying with the quality of the cane. If the cane is too old or has been burnt or is otherwise unsuitable for the main product, the molasses percentage increases.

Producing areas

About 85% of Indonesia's sugar comes from East Java, where smallholdings increased considerably in 1952 and yielded an average of 7 tons per hectare, compared with 6 tons per hectare in 1922, when the area devoted to sugar was at its greatest. Central Java is also an important sugar-producing district.

TABLE 1
ESTIMATED PRODUCTION OF SUGAR

	1953	1954	1955
Factory sugar:	*tons*	*tons*	*tons*
Production	574,000	700,000	850,000
Domestic consumption	424,000	425,000	450,000
Available for export ..	150,000	275,000	400,000
Smallholders' sugar:			
Production	215,000	400,000	500,000
Domestic consumption	150,000	150,000	175,000
Available for export..	65,000	250,000	325,000

New factories

The opening up of new mills and the repair of existing ones will, the Indonesian Government hopes, encourage greatly increased production of factory-processed sugar during the next few years. It has been announced that a new factory is to be established at Djogjakarta at a cost of about 80 million rupiahs, part of which will be borne by the Central Government. The Tjepiring (Kendal) sugar factory, the repair of which, at 30 million rupiahs, was started in 1951, is to be put in production this year, while repair work is to begin on the Purbolinggo factory at a cost of 20 million rupiahs. During 1952, the Indonesian Government had already granted 355 million rupiahs to pay for repairs to other sugar mills in Central Java.

The Government is encouraging co-operation between the smallholders and the sugar factories so that the facilities provided by the latter may be utilised to the full.

As well as having a considerable potential export value, sugar holds a vital place in Indonesia's domestic economy. It is estimated that 16 million Indonesian families each consumes about 6 kg. of sugar a month. This represents a total annual consumption for the whole of the country of approximately 1,152 million kg. of sugar of all varieties.

Exports

In 1940, the value of crystal sugar and molasses exported by Indonesia amounted to 53.1 million rupiahs, or approximately 9% of the total value of her agricultural exports. In 1950, exports of crystal sugar were valued at only 1.4 million rupiahs, or 0.07% of the total value of Indonesian agricultural export products in that year. By 1951, at 4.5 million rupiahs, the export value percentage of crystal sugar had risen slightly to 0.15. In 1952, the total production was estimated to be sufficient to meet only internal demand, while in the first half of 1953 sugar exports amounted to only 683 tons.

Under the International Sugar Agreement of 1937, Indonesia's basic export quota is 1,050,000 tons. With increased production over the next few years Indonesia again hopes to provide a substantial quota for export as well as satisfying home needs.

Bundles of sugar cane ready for despatch to the sugar factory

The Agricultural Revolution in Turkey—1

Continued from page 142

of the administration comparable to that expended on the present programme, but a considerable adjustment in the attitude of many farmers. It has been stated that 'opinion in Turkey on the danger of ploughing-up pastures is by no means unanimous. Even a poor wheat crop is regarded by the farmer as a better proposition than the unproductive pasture it has replaced.'[7]

It will not be easy to alter this outlook and intensive research, demonstration and advisory work on pasture and fodder-crop husbandry, range improvement and livestock management, will be required. The response which Turkey is making to this challenge will be discussed more fully in our next article.

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New Appointment

Mr. F. Clark, M.A., B.Sc., A.R.I.C., has resigned his post as Editor of the *Journal of the Science of Food and Agriculture* and *Reports on the Progress of Applied Chemistry*, and has taken up his appointment as Secretary of the Editorial Board of The Biochemical Society.

International Standardisation of Farm Tractor and Machinery Details

FROM November 10 to 17 meetings were held in Lisbon, Portugal, of the two technical committees on agricultural engineering products of the International Organisation for Standardisation (I.S.O.). Committee TC/22T (Agricultural Tractors) achieved important progress, while Committee TC/23 (Agricultural Machinery) advanced to the stage of making a thorough examination of the many obstacles that must be surmounted in order to achieve interchangeability of even simple parts.

Agricultural tractors

P.t.o. and drawbar. The speed of the p.t.o. recommended in 1952 was 550 r.p.m. $\pm$25 at rated engine speed. This matter was reviewed on the suggestion of the British delegation, and a standard p.t.o. speed of 540 r.p.m. $\pm$10 was eventually agreed on. This is very close to the existing British and American standards (536$\pm$10). It was considered that future developments are quite likely to call for a p.t.o. of higher speed; but since the speed that is likely to be needed will probably be very much higher, *e.g.* around 1,000 r.p.m., it was considered that no slight increase over the existing standard could hope to meet such a potential demand.

Further consideration was given to the relationship between the position of the p.t.o. and that of the drawbar, and the recommendations made in Paris for a p.t.o. height of 20 to 31 in. and a drawbar top height ranging from 5 in. to 23 in. (including adjustment) was also confirmed. The difficult problem of relating the p.t.o. position to that of the links in a tractor having 3-point linkage fitted had, however, to be referred back to the Secretariat for further study, and Britain was asked to make proposals after studying the whole subject in the necessary detail. The object of standardisation in this case is to ensure that all p.t.o.-driven mounted implements can be used effectively with any tractor having 3-point linkage.

The committee unanimously adopted a recommendation for a standard for p.t.o. guards, having dimensions identical with the U.S. and British standards.

3-point linkage. The British delegation achieved a major objective when the British standard for the 3-link hitch was adopted practically unchanged as the I.S.O. recommendation for mounted implements. Some Continental countries which had thought in 1952 that other forms of implement mounting might become important enough to make a 3-link standard valueless had changed their minds during the interval; and the fact that Germany had adopted a national standard based on the British helped to secure approval of the details as set out in B.S.1841 : 1951.

Wheels. It was decided to study the question of fixing devices for tractor wheels, particular attention being paid in securing interchangeability of the front wheels. A proposal for a joint meeting with a committee dealing with rubber tyres was also agreed, the object here being to prepare a standard list of tyre sizes.

Tractor testing. Tractors are now tested in many European countries, as well as at the N.I.A.E. and at Nebraska, U.S.A. Unfortunately, there have hitherto been small differences between testing methods in different countries, and the object of the discussions was to adopt an internationally agreed testing procedure. Agreement was reached on details of the methods to be employed in testing maximum performance under controlled conditions, and arrangements were made to continue the discussions later, with the object of preparing agreed recommendations on methods of conducting field trials.

Agricultural machinery

Progress in Committee TC/23 (Agricultural Machinery) was less substantial, but was as much as could be expected in view of the difficulty of the problems. In the case of agricultural discs and mower parts the work is still at a fairly early stage, and consisted chiefly of revising the Secretariat's proposals in an effort to make draft recommendations likely to be acceptable to the various member bodies.

Glossary and numbering system. Britain had been asked by the Secretariat to present proposals for a numbering system for an international glossary of agricultural machinery. This request had resulted in the numbering system employed in the British Standard Glossary (B.S.2468 : 1954). This numbering system was discussed and duly accepted as the basis for developing an international glossary which, it is hoped, will be illustrated and will give terms and definitions in at least English, French and German, and possibly in one or two other languages.

International standardisation is inevitably an even slower process than national standardisation, but its effects are ultimately important on account of its great influence on the work of National Standards Associations. The slow pace of progress in the matter of agricultural tractors and machinery is indicated by the decision to hold the next meetings of the full committees in 1956; but in the meantime, an attempt will be made to solve some of the problems by means of smaller 'working groups.'

Technical News

Food Manufacture for April contains 'Preserved Foods for the Swedish Larder, 1,' by C. H. Sporle; 'Peanut Butter, 1; Progress Report: Vitamins, 2,' by F. A. Robinson and 'Preventative Maintenance of Canning Plant' by D. A. Browne.

The contents of *Fibres* for April include 'Fibre Prospects in the South Pacific' by Eric Ford.

Dairy Engineering for April is devoted to special aspects of the butter and cream industries.

The April issue of *Manufacturing Chemist* includes 'The Nature of Wool Wax and its Economic Future' by D. H. S. Horn, Ph.D., 'The Phytosterols of Soya — Chemistry, Properties and Uses' by A. Matagrin and a progress report on fertilisers and plant nutrients.

Hybrid Maize in Egypt

MAIZE is one of the most important crops in Egypt. The area planted is approximately 1,500,000 feddans with an average yield of approximately 6.32 ardebs (1 ardeb = 140 kg.). It is mostly used locally for human food; but it is not sufficient to supply the local consumption in Egypt, and large amounts have to be imported.

This report from the Plant Breeding Section (Maize Branch) of the Egyptian Ministry of Agriculture describes the work undertaken to improve and develop hybrid maize.

Research programme

The Plant Breeding Section of the Ministry of Agriculture has been following a programme for improving maize production in Egypt since 1916. This is summarised in the following steps:

1. Breeding for improved open pollinated varieties. Local and imported varieties are included in this programme using the following methods:

(*a*) Mass selection.

(*b*) Improved ear to row selection.

(*c*) Yield trials and comparison of the varieties.

By these means high-yielding varieties were selected, such as American Early which represents the dent varieties, and Giza Baladi for the flint varieties. These two varieties exceeded the local varieties by at least 10% to 15%.

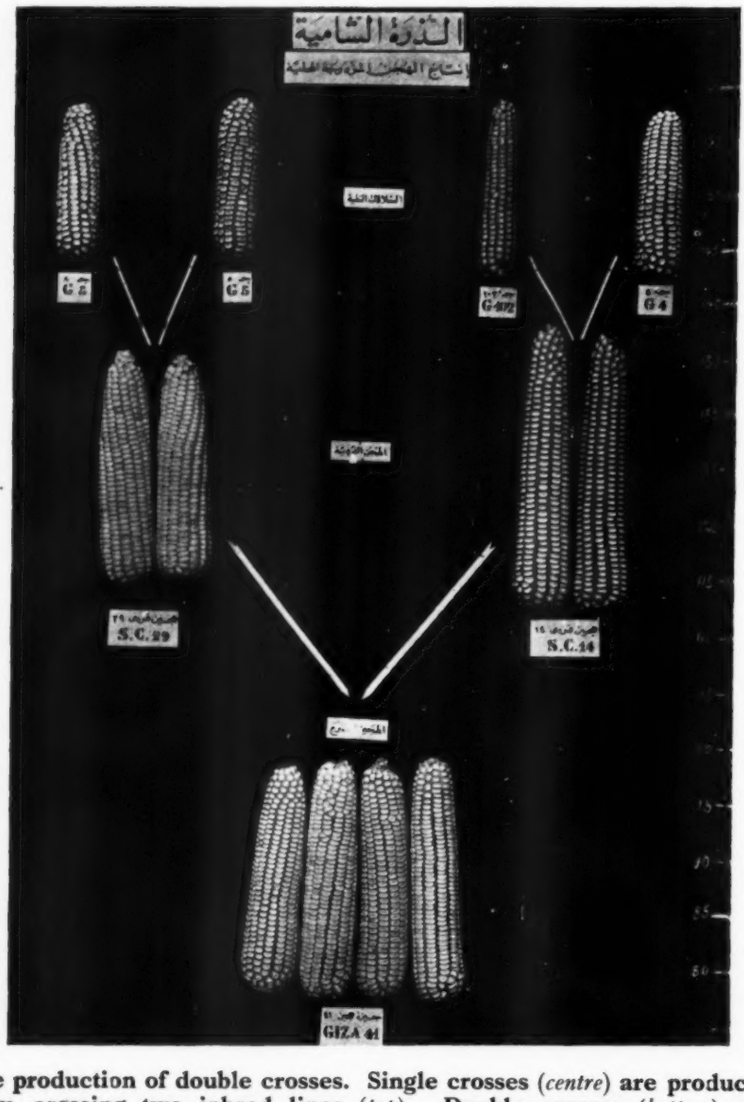
Methods of back crossing and producing synthetic varieties were also in the breeding programme.

2. The production of hybrid maize has been carried on since 1949 and many inbred lines, single crosses and double crosses produced. The procedure which has been followed is:

(*a*) Breeding for the inbred lines by 'salfing' the local and imported varieties for several generations according to the purity of the variety. Selection of the desirable characters is made continuously in the following generation.

(*b*) Tests of the inbred lines and all the possible combinations of the selected ones have been made for the production of top crosses which showed the best predictions on a small scale for test.

(*c*) Production of the selected double crosses on a large scale for distribution to the farmers.



The production of double crosses. Single crosses (*centre*) are produced from crossing two inbred lines (*top*). Double crosses (*bottom*) are produced from crossing two single crosses

The experiments

The experiments have been made in localities which represent the different districts of Egypt for comparison between the selected varieties and the hybrids. Notes were taken in the field and store for the morphological characters of the plant and seeds.

More than 250 double crosses received from the Food and Agriculture Organisation of the U.N. were tested during the last four years, the results being given annually at the maize meeting held by FAO.

The experiments conducted have identified several hybrids of both American and local origin which persistently outyielded the American Early. These experiments have demonstrated that adapted hybrids are fully

effective in increasing maize yields in Egypt. The average increase in yield obtained from the better hybrids in the trials has amounted to about 30%. These data were the basis for the hybrid maize project.

The programme of this project is divided into the following categories:

1. The breeding programme.
2. The production of foundation seed.
3. The production of the selected local double crosses.
4. The production of the imported double crosses, which gave the highest yield in the yield trials for at least three years.

The steps of this project were carried out since 1953 with the co-operation of the Technical Co-operation of America (Point IV).

Production of double-cross seed of the local double crosses Giza 76 and Giza 41 was made in an area of about 500 feddans. Production of the imported double crosses which proved high performance under the Egyptian environment (Dixie 33, U.S. 523W) was also made in about 100 feddans. This area will be increased and doubled annually. The crop produced will be distributed to the farmers by the Ministry of Agriculture.

Research work

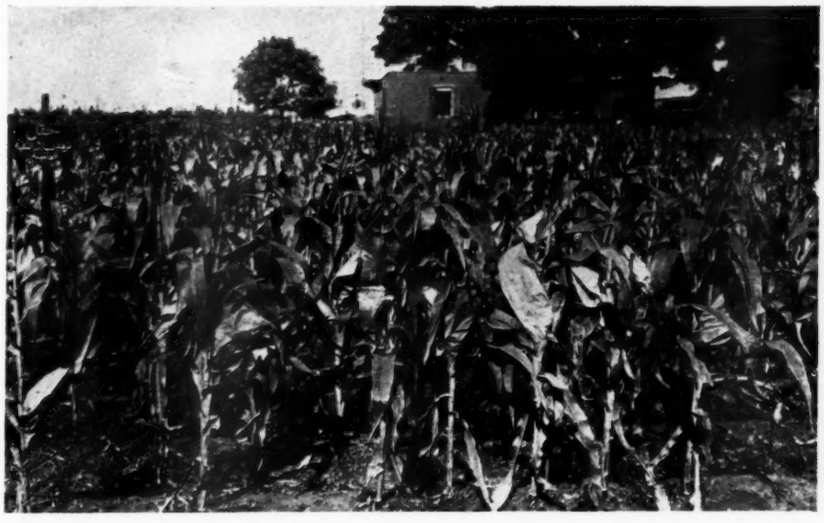
Besides the routine work some research problems are carried such as:

1. The determination of the factors for borer resistance in a resistant inbred line imported from the University of Minnesota. Translocation stocks are used in this study.

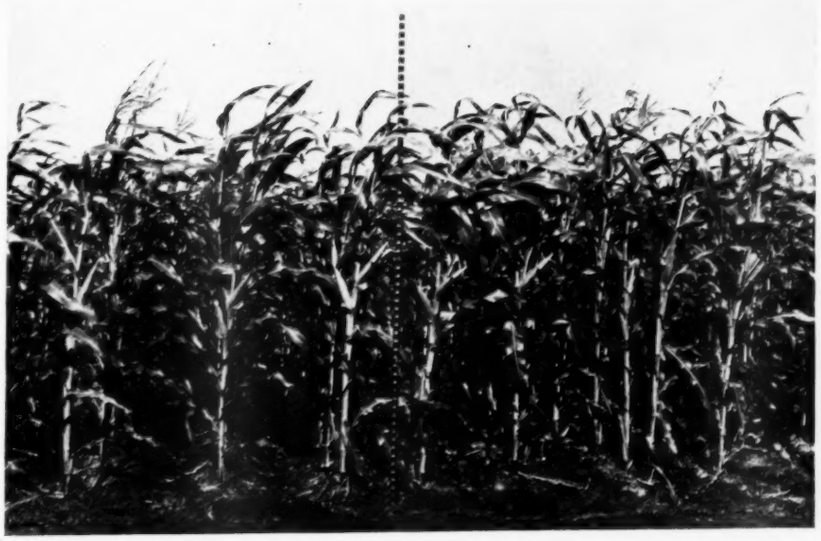
2. Cytoplasmic male sterile study to produce male sterile lines to be used in the production of the single and double crosses without the need of detasselling. This will reduce the expenses of the hybrid maize production.

Studies on the improvement of planting methods, disease resistance, soil analysis, and fertilisers are conducted by the Plant Breeding section with the co-operation of the sections of Plant Pathology, Chemistry and Entomology.

The section welcomes those who are interested to visit its experiment stations or to study the steps of maize improvement in Egypt.

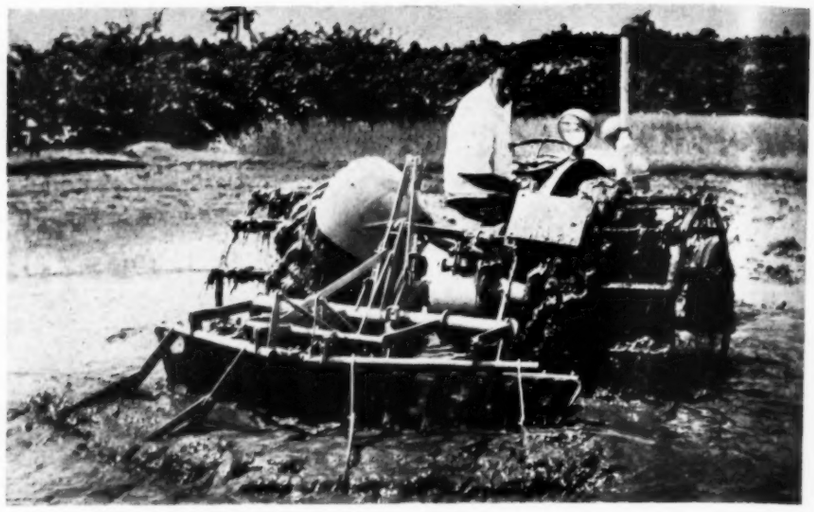


The field of the local inbred lines at the farm of the Plant Breeding Section at Giza. (*Below*) **The artifical production of single crosses. The cross is made between two inbred lines**



A field of the local double cross 76 production at Mehallet Mussa Experiment Station (Lower Egypt)

Indian Paddy Machinery in Ceylon



The Ferguson tractor fitted with wheel extensions and operating the special rice harrow. This implement is a fully-mounted disc harrow, with 12 scalloped discs: levelling boards may be seen attached to the rear of the implement

In its desire to establish greater self-sufficiency in food production in the island, the Ceylon Government recently arranged for a detailed review to be made by a Commonwealth Rice Mission consisting of Sir Robert Hutchings, Dr. Rhind and other members from the United Kingdom and Australia. Before finalising their work, the mission expressed interest in the cultivation of wet-paddy by machinery, as was recently demonstrated to the FAO International Rice Conference in Tokyo by the Massey-Harris-Ferguson Organisation.

In conjunction with their Ceylon distributors, Messrs. Brown and Co. Ltd., a demonstration of this equipment was given on the outskirts of Colombo of the adapted Ferguson tractor with special rice harrow as developed in India. In addition to members of the mission, also present were Sir Cecil Syers, the U.K. High Commissioner, Mr. Alvapillai, Permanent Secretary to the Ministry of Agriculture and Food, the Director and Assistant Director of Food Production, the principal U.K. Trade Commissioner, the deputy chairman of the Gal Oya Development Board, local officers of FAO, executives of Gal Oya Valley Food Production Co. and others.

Spectators were greatly impressed by the work performed by this equipment, especially in view of the condition of the site chosen. This was a clay-soil field that was last cropped several years ago and was accordingly covered by very heavy top growth. Conditions were certainly very wet, for no water control was available and in many places it was possible to push a bamboo 4 to 5 ft. into the soil before finding any hard core.

Wet puddling in these conditions in such very small areas—only about $\frac{1}{8}$ acre—was claimed to be well beyond the capability of any other power machinery yet developed, but the Ferguson tractor, with its special, though simple, equipment, succeeded in cutting and burying the heavy growth and preparing a mulch which was recognised as being of much higher quality than could be prepared by animals.

The tractor and equipment cost less to purchase and to operate than the number of bullocks and animal implements required to perform the same amount of work in the same time. The following figures indicate the cost of operating under both methods of working:

CAPITAL OUTLAY

(estimated for India in Indian rupees)

Machinery

	Rs.
Tractor	7,700/-
Implement	1,325/-
Wheels	200/-
Accessories	175/-
Total	9,400/-

Animals

	Rs.
Ten pairs of bullocks at Rs. 1,000/- per pair	10,000/-
Ten bullocks' ploughs at Rs. 22/- each	220/-
Total	10,220/-

Operating cost: Based on 100 acres wet-paddy cropped twice yearly. Total area to be puddled, 200 acres.

Ten pairs of bullocks will be required to complete the puddling in the same time as one tractor. Average costs for this operation are quoted and are believed to be applicable to many areas.

Tractor

Speed: One acre in 2½ hours.

Labour

	Rs.
One driver at Rs. 2.8.0. for 62 days	155/-
One cleaner at Rs. 1.0.0. for 62 days	62/-

Fuel

Fuel and oil:	
500 gal. powerine	875/-
31 gal. petrol	93/-
15 gal. oil	112/8
Incidentals	100/-
Total	1,397/8

Bullocks

Speed: One pair, one-third acre daily.

Labour	Rs.
600 days at Rs. 1.8.0. (*i.e.* 10 drivers for 60 days	900/-
Fuel and Food	
600 days at Rs. 2.0.0. per pair..	1,200/-
Total	2,100/-

No allowance is shown for depreciation; since both animals and machine should be depreciated at the same rate.

NEW BOOKS

Advances in Agronomy

Vol. 6. Academic Press Inc., New York. 1954. $8 or £3 3s.

This periodical continues to cast its net widely and serves a useful purpose in emphasising the diversity of subjects which fall within the category of agronomy. In the preface to volume 1 the editor stated that contributions to later volumes would be sought from workers in countries outside North America. It is disappointing to find that after a brief excursion abroad in volumes 2 to 5 the homing instinct has proved too strong, and all articles in the volume under review emanate from North America. This need not in itself detract from its value, but in the case of ' Progress in Range Improvement ' the use of popular names of plants, sometimes with the omission of scientific names, reduces the value of the contribution to non-American readers. Some interesting points are made concerning range management, but there are many statements with which it is difficult to agree; for example, where dealing with natural reseeding and natural selection: ' Nature gives little consideration to factors such as seed production, seedling vigour, or forage production.' A short review on soil water availability follows, concerning mainly data derived from investigations made in the United States.

' A Pattern for International Collaboration in Agriculture ' reviews the progress made in agricultural aid to Mexico administered jointly by the Rockefeller Foundation and the Mexican Government and suggests similar schemes for aid to other agriculturally under-developed countries.

An article on ' New Concepts of Management of Corn Belt Soils ' will appeal to those eager to experiment in unconventional tillage practices, although numerous tentative statements as ' Such data as these tend to support the concept that high yields cannot be obtained without adequate nitrogen fertilisation . . . ' make the reading rather tedious.

A contribution of wider interest, ' Seed-flax Improvement,' reviews advances in this field during the past 20 years, and is useful to all concerned in flax growing. It covers storage properties, diseases, weed problems and control, and breeding. The omission of references to the work of Muskett and Muskett and Colhoun on flax diseases, and particularly seed-borne and seedling diseases, is surprising.

A short article on trace element usage stresses the importance of the acid radicals of salts in determining their efficacy. This is followed by ' Crop Adaptation and Climate,' which is an essay on ecology with special reference to plant geography and distribution and the measurement and effects of different climatic components on plant growth.

' Potassium in Plant Nutrition ' reveals that little is known of the physiological action of potassium in sufficiency or deficiency, although some of the effects are known and described for a wide range of crops. The detection of potassium deficiency is treated, and useful remarks are made on the dangers resulting from an imbalance of nutrients. The section on uptake of potassium by roots contains the remarkable statement: ' Corn plants which had part of their roots in contact with dry soil absorbed 70% more potassium than did plants grown in potassium-free sand.'

The final article is an interesting and well-presented review of the development of sorghum as a crop in the United States. A section is devoted to the improvement of varieties to suit regional climatic conditions, and gives figures to show the effect of length of growing season on forage yield. An account of sorghum-breeding methods and sections of cytology and genetics and the production of hybrids conclude this useful contribution.

This volume contains articles of interest to those concerned with agronomy either as practising farmers or as research workers, but the half-tone blocks are generally of poor quality, which detracts from their value as relevant illustrations. It is much to be hoped that the high standard set by the first volume will be maintained in succeeding years.

R. L. Lucas

The Fruit Annual, 1954-55

By H. F. Tysser. London. British-Continental Trade Press. 1954.

The 1954 edition of this annual year book and directory of the world's fruit trade marks a considerable advance on its predecessors. It contains, as usual, a large number of sections, some of which are new. Outstanding new features are articles on ' Mechanisation in Citrus Orchards,' ' Packing Sheds,' ' Quick Freezing ' and ' The Transport of Perishable Goods Between the Continent and Great Britain.' There is also a valuable survey of the world fruit trade which gives details of the imports and exports from a large number of countries in different parts of the world. In different sections the book deals with edible nuts, dried fruit and tropical fruit, the last being an important innovation. There is also the usual ' Fruit Shippers' Guide,' which gives the alphabetical list of shipping companies, and a ' Directory of the World Fruit Trade,' which lists all the various firms concerned with handling fruit in different parts of the world. There are numerous advertisers, while the book contains many illustrations.

The book is one which should be on the table or in the library of all concerned with the fruit trade.

Weed Control in Farm and Garden

By Stephen J. Willis. Pp. 184. Vinton. Agricultural and Horticultural Series. 1954. 8s. 6d.

Mr. Willis has written this small book primarily for the farm institute students that he has to teach. He has assumed neither an understanding of chemistry or botany, nor a knowledge of the husbandry of agriculture or horticulture. He has, in fact, started from the very first principles. This, while admirable in the section dealing with chemical weed control, seems a little unnecessary in the chapters concerned with the objects of controlling weeds and the cultural methods employed.

Modern methods of weed control, although based on good husbandry, are very much concerned with chemistry and the mechanics of applying liquids or dusts. Development in this new technology has been rapid and the result mainly of industrial enterprise.

Teachers and agricultural advisory officers have, in consequence, found it difficult to keep pace with the progress of new developments and, as a result, the farmer and the grower have tended to turn to industry for advice and technical literature. Several textbooks dealing with this new technology have been published in other countries, but this is the first dealing specifically with conditions in Great Britain and the author is to be congratulated on filling a very definite requirement.

Ten of the 17 chapters are concerned with chemical weedkillers and their methods of application, and the author succeeds in his attempt to explain from first principles the way in which the chemicals act and the reason for the recommendations that are made. The subject matter is accurate, up to date and carefully assessed. The text contains a few illustrations, a useful index and an appendix of chemical names and formulae. It should serve as an admirable textbook for schools and farm institutes as well as being a useful introduction and guide to this difficult subject for the more inquisitively-minded farmer and grower.

E. J. WOODFORD

Fruit Nutrition

By Norman F. Childers (Editor). Horticultural Publications, Rutgers University, New Brunswick, N.J. 907 pp. 132 plates. 1954.

The recognition of the importance of nutritional deficiencies in crop production has been one of the major advances in applied plant physiology. Led by Prof. Wallace in this country and the late Prof. Hoagland in the U.S.A., innumerable research workers all over the world have gathered a mass of data on symptomatology, analysis, yield response and quality in all the major crops. In no field has this study been more intense than in pomology and the 28 authors who have compiled this book have rendered a real service in gathering together so much of the available knowledge and publishing it in one comprehensive, if bulky, volume.

Each of the fruits grown in the United States is treated separately by one or more different authors and the roles of the individual nutrient elements dealt with in relation to that crop. The largest section is, naturally, that on the apple, admirably treated by Dr. Boynton, of Cornell. The opportunity is taken in this chapter for a discussion of related physiological principles of general application. The book concludes with four additional and very useful chapters: an account of the use of isotopic tracers in nutrition research; the latest information on chelated metals as a means of overcoming trace element deficiencies; experimental methods with orchard trees; and an extended reproduction of Gregory and Goodall's compilation of data on nutrient content of tissues in relation to deficiency or toxicity symptoms.

If any criticism may be made, it is that the binding of the volume would seem hardly good enough to stand up to the hard usage it will undoubtedly have as a standard work of reference.

R. H. STOUGHTON

Progress in Milk Production

By J. Clark and J. E. Bessell, Imperial Chemical Industries Ltd. Central Agricultural Control Bulletin No. 5.

Based on four years of data (1949-52), this 91-page bulletin reports in detail on the production of milk on 40 farms co-operating in the grassland management investigation of Imperial Chemical Industries Ltd. Now, as it appears, the margin between the average milk price and cost of production seems likely to become less. For this reason, since the bulletin examines carefully some methods of improving efficiency in milk production, it may be very timely.

On the farms discussed, the general policy is to improve both the production from grassland and the efficiency of feeding the grass, and the effect of this policy on profit per cow and per acre has been examined. The summer and winter feeding of the dairy herds and relevant topics are discussed. Among these is the relation between profit per cow and profit per acre and how the farmer can increase them. For example, it was found that profit per acre increased uniformly with profit per cow up to a level of £50 per cow. In order to obtain this profit per cow the utmost use of grass should be made, provided (*a*) this does not limit the herd yield, at least, up to a level of about 850 gal. per cow and provided (*b*) that cows are fed concentrates according to their yields. Dairy herd profit per acre was found to be greatest when production exceeded 300 gal. per (cow-feed) acre. Milk production per acre can be increased both by higher herd yield or higher stocking density, but the study indicated that yield per acre could be more rapidly increased by the latter. Other important aspects examined include the relative costs of the main foods and the effect of fodder crop yields on milk output per acre. The use of nitrogen on grassland for milk production receives special consideration.

The results are presented so that the layman can appreciate the main findings of the study without a knowledge of statistical methods, although these have, of course, been used to analyse the relationships between the various factors of production. The general reader will also find the outline at the beginning of each chapter helpful. The bulletin concludes with a summary of the whole study. Diagrams in the text illustrate much of the data which is separately tabled in detail in the appendix.

English Ministry of Agriculture Review

The Minister of Agriculture and Fisheries announced in a written answer in the House of Commons recently that he had appointed a committee of independent persons to review the provincial and local organisation and procedures of his department.

The committee will consider generally whether the present organisation is best adapted to secure efficient and economical performance of the department's functions, and in particular whether there is undue complexity, over-specialisation, or overlapping inside the organisation, or duplication and unnecessary interference with the work of local authorities. In view of the decision to amalgamate the Ministry of Agriculture and Fisheries and the Ministry of Food, the committee will have regard also to the remaining similar organisations of the Ministry of Food. The terms of reference also provide for the committee's work to cover the examination of methods of dealing with agricultural land transactions within the Ministry of Agriculture and Fisheries and the Agricultural Land Commission.

FARM MACHINERY

New Swingfog Unit

The 'Swingfog' pest-control unit was introduced into Great Britain and the Commonwealth in 1952 and it is now playing an important part in many different territories in the battle against destructive and disease-carrying insects and for crop protection.

Nevertheless, as the first model of the 'Swingfog' unit only produced a dry fog at a fixed particle size, it had, as a result, serious limitations. The new model of the machine, the SN6, produces both fog and spray and in both cases the droplet size can be varied at will by the operator. The new model also incorporates a number of important mechanical improvements, making the machine still easier to handle and maintain.

The mechanical improvements which have been made are as follows:

Starting

A coil and sparking plug are now used in place of a glow plug. The lower amperage required allows a pocket-size 6-volt battery, rechargeable and weighing only 2 lb., to be used for starting. However, where it is more convenient, a 6-volt car battery can still be used.

Cooling

The air circulation has been improved, leading to cooler running, and at the same time the guard has been extended to protect the operator completely from accidental burns.

Materials and finish

In some parts of the machine improved materials have been used, whilst in other parts heavier corrosion-resistant plating has been employed. The exterior finish has also been improved and the general overall appearance is much neater and more streamlined — an important point when working amongst crops or in bush. All parts of the machine are now replaceable.

Output

The output of the machine has been increased from 2-3 g.p.h. to 2¼-6¼ g.p.h. As the weight has not been increased, the output/size ratio of the machine is even higher than it was.

The output rate of the SN6 is controlled by a series of different-sized jets which can be quickly changed whenever the operator desires. The droplet size of the fog or spray is also governed by these jets, since droplet size varies with flow rate of the insecticide so long as the air flow and air temperature remain steady. The droplet size goes up as the flow rate increases. The nature of the insecticide solvent and the temperature will cause some slight variation of course. Table 1 gives the output of SN6 for oil and water base formulations.

TABLE 1

Jet	*Material*	*Output*
0.8	Diesel Oil	11.6 litres/hr.
0.9	,, ,,	13.6 ,, ,,
1.0	,, ,,	15.4 ,, ,,
1.1	,, ,,	18.3 ,, ,,
1.2	,, ,,	22.0 ,, ,,
1.4	,, ,,	28.5 ,, ,,
0.8	Water	12.4 litres/hr.
0.9	,,	14.1 ,, ,,
1.0	,,	14.4 ,, ,,
1.1	,,	15.9 ,, ,,
1.2	,,	19.2 ,, ,,
1.4	,,	24.3 ,, ,,

The machine has been adapted for spraying by the design of a special ring-type atomiser. The fluid, under slight pressure, meets a stream of moving air at the edge of an annular nozzle and is atomised by the action of the air stream, which is hot and pulsating.

The question of droplet size when applying insecticides and fungicides is a very important one and fortunately this is being increasingly recognised. It is regrettable, therefore, that considerable confusion and inconsistency is to be observed in the descriptive terms being used. The World Health Organisation has suggested the following usage, which is both reasonable and practical:

TABLE 2

	Microns
Aerosol	0.1-50
Mist	50-100
Fine spray	100-400
Coarse spray ..	400 or more

The term aerosol, it must be added, covers a number of different methods of producing them and includes those generated by purely mechanical means, smokes produced by controlled combustion of a chemical mixture containing insecticide and fogs which are produced by the action of hot air or, less commonly, superheated steam. Operators of fog machines have coined the terms 'dry' fog and 'wet' fog. A dry fog is one that will not leave any

The 'Swingfog' machine being used to control tsetse in Nigeria

visible deposit even when used indoors in houses containing polished furniture, pictures and other valuables. A wet fog, on the other hand, will leave a deposit and is used, for example, when fogging warehouses. In terms of particle size, a dry fog is made up of droplets of 15 microns and less and a wet fog of droplets over 15 and less than 50 microns in diameter.

When using the ring-type atomiser, the ' Swingfog ' machine produces a mist or spray, depending on the jet size being used. The mist or spray from the ' Swingfog ' receives some driving force from the air stream of the machine, which controls it for about 4 to 5 yd. from the nozzle; after that the wind takes charge of the droplets. For use out of doors the machine is essentially, therefore, a drift rather than a placement sprayer, to use the convenient classification suggested by Courshee (WORLD CROPS, January 1955). Even so, the larger size of the spray droplets will enlarge the machine's scope in the crop protection field very considerably, especially for applying fungicides and insecticides relying for their effectiveness on their residual activity.

Seed Spacing Drill

Plants used for agricultural and horticultural crops—since broadcasting was abandoned as a general practice—have been sown in rows, these varying in spacing according to plant specie, soil and climatic conditions. ' Living space ' for the plants in one direction was thus provided mechanically. ' Living space ' in the second direction (in the row) was provided by manual or mechanical and manual thinning. This thinning provided the ' living space ' in the row.

To save labour cost of thinning and to enable this job to be done at a convenient time precision seeders or ' seed-spacing drills ' were developed, these drills aiming at placing seeds at predetermined spacing in the rows.

Seed-spacing drills have been designed and developed in many countries with varying degrees of success. Not all of these seed-spacing drills comply with the basic requirements, which are:

1. Machines which do not bruise or crush the seed.
2. Machines which can quickly and easily be changed from one kind of seed to another and from one spacing to another.
3. Machines which minimise the rolling of the seed after release from the machine.
4. Machines which will warn the tractor driver if any seeder unit attached to the tractor toolbar stops functioning or when the hoppers need filling with seed.

One seed-spacing drill, the ' Stanhay,' which is exported by S. Berendsen Ltd., appears to fulfil these conditions, as evidenced by it having been given first prize at the Precision Root Drill Competition in 1953 and silver medal by the Royal Agricultural Society of England in 1954. Reports made by the various testing stations abroad also speak highly of this particular seed drill. We quote from such reports:

' No indication of excessive grinding or breaking of the seed was found after laboratory and field tests were concluded.'

' The test proves that the "Stanhay" seed-spacing drill sows the seed with more than exactitude.'

The ' Stanhay ' drill, according to the manufacturers' claims, can be used for sowing most seeds singly or in groups. It is available for tractor draft, but a hand-pushed model is also available. Experiments with the precision seeder for cereals (wheat, oats, rye etc.) have been undertaken at foreign experimental stations, but results are not yet available.

Mr. S. J. Wright

Mr. S. J. Wright, M.A., Agricultural Advisor to Ford Motor Co. Ltd., of Dagenham, Essex, has been seconded to the Commonwealth Relations Office to go to India under the technical co-operation scheme of the Colombo Plan.

The Indian Government want to set up a testing station in their country for tractors and other agricultural machinery similar to the National Institute of Agricultural Engineering in England, of which Mr. Wright was the first director.

Mr. Wright sailed for India in January and expects in the first instance to be there for two or three months. Later he will return to establish the centre and put the scheme into operation.

The Danarm 'Whipper'

The Danarm ' Tornado ' petrol-driven one-man chain saw has been superseded by a new saw which the makers, J. Clubley Armstrong Danarm Ltd., are calling the ' Whipper.' This new saw will perform all the functions of the ' Tornado,' such as felling, lopping and cross-cutting, and embodies a number of new features. The new machine is very light—it weighs only 27 lb., with a 14-in. guide blade and is excellently balanced in both the felling and cross-cutting positions, which makes it easy to carry up on to timber stacks, or into trees for awkward lopping or havoc clearance.

An unusual feature is the precision gearbox, and the centrifugal clutch enables the operator to change hands or work with one hand only and permits the gearbox and blade assembly to be rotated to any angle independently of the engine. Very low cuts can be made with the blade horizontal.

It is stated that the engine, which is entirely new, stands up to rough handling and will not stall when overloaded. A rewind pull-starter has replaced the old cord-starting system. Oil is fed directly on to the chain by automatic pump and an oil-metering device with visible gauge shows the oil level at a glance.

WORLD CROP REPORTS

WORLD

Breadgrain production. World breadgrain production in 1954-55 is estimated at about 246 million short tons. Although less than the harvest of wheat and rye for the past two seasons, this is well above the 1945-49 average of 218 million tons. For the current season, wheat accounts for 83% and rye for 17% of the total world production of these breadgrains. World production of wheat is now estimated at 6,790 million bushels. This estimate, which is 80 million bushels below the earlier-season estimate, is 470 million bushels less than the large 1953 wheat harvest, but is 950 million bushels above the 1945-49 average.

The net decline from the earlier wheat estimate was largely in exporting countries. The reduction was especially marked for Canada, where the latest official estimate is 79 million bushels below the previous official forecast. A minor reduction in the United States estimate contributed to the net reduction of 82 millions for North America. The crop in Australia is also expected to be smaller than was forecast earlier.

Wheat production in North America is now estimated at 1,289 million bushels. Although well above the pre-war level, the current estimate is 50 million bushels below the large crop of the past year and is the smallest out-turn in this area since 1943. Both the United States and Canada report the smallest out-turn since that year.

The area under wheat in North America was 16% less than in 1953, with the bulk of the reduction in the United States. Wheat acreage in Canada was about a million acres less than in 1953, but the bulk of the crop reduction is due to small yields, resulting from unfavourable weather during much of the growing and harvesting season. The current yields, estimated at 12.3 bushels per acre, contrast with the average of 24.1 bushels last year. This is the smallest yield reported since 1937.

Wheat production in Europe is estimated at 1,730 million bushels, about the same as in 1953, and one of the largest out-turns ever reported for that area. A net increase for Western Europe offsets a reduction in other Europe, especially in the Balkan area. Conditions in Western Europe are variable, with an all-time record harvest in France offsetting a substantial reduction from the large 1953 crop in Italy. A sharp increase in the out-turn in Spain is another feature of the Western European situation. Yields of 16.9 bushels per acre in Spain contrast with the very low yields of 11.8 bushels for 1953.

Rye production in Europe is estimated at 685 million bushels, about 50 million bushels larger than the 1953 total. Production was somewhat larger than in 1953 in Western Germany mainly because of expanded acreage, though yields were also reported larger than in 1953. Production in Poland, the ranking rye producer of Europe, also appears to have been somewhat more than that of a year ago.

The production of breadgrains in the Soviet Union in 1954 is apparently somewhat higher than in 1953 largely because of increased wheat acreage and good yields in the eastern regions, which offset losses suffered in the drought-stricken areas of the south. Increases in wheat acreage bring the total breadgrain area well above the pre-war level.

Wheat production in Asia is placed at 1,735 million bushels, very slightly above the large 1953 production. A number of important producers show substantial increases over the 1953 out-turn, but those gains were largely offset by the reduction of 100 million bushels reported for Turkey. Rye production is of minor importance in this area. The current crop of 17 million bushels is only about half the large 1953 harvest, principally because of the sharp reduction in Turkey, the only producer of significance in the area.

Africa's wheat crop is estimated at a new record high of 205 million bushels. A record crop in Egypt, together with record or near-record out-turns in French North Africa, bring the total 43% above the pre-war average. Rye production is of no significance in this area.

The wheat harvest now under way in South America is forecast at 360 million bushels. This is larger than the 1953-54 harvest and is well above average. Conditions are favourable in Argentina, the principal producer of that continent, and the present outlook is for a crop of about 260 million bushels. If realised, that production would be 14% above the 1953-54 crop as well as above average. The wheat acreage seeded is about the same as that of the past season. Rye production for Argentina is forecast at about 31 million bushels, which is much above average and also larger than last year's harvest.

Wheat acreage for harvest in Australia is about the same as the acreage harvested last year. Growing conditions have been much less favourable this season, however, and the total out-turn will be somewhat smaller than the 1953-54 crop. Present conditions indicate a total crop of 165 million bushels or less. Conditions have been least favourable in New South Wales and the out-turn in that state will be sharply below the harvest there last year. Rye is of no significance in Australia.

Cocoa production. World production of cocoa for 1954-55, previously forecast at 1,649 million lb., now is revised upward to 1,782 million lb. This compares with 1,586 million lb. for 1953-54 and 1,658 million lb. for 1952-53. The current estimate is 12% above 1953-54, 7% above 1952-53 and 13% above the pre-war (1935-36/1939-40) average. Since the earlier estimate outstanding increases have occurred in both Brazil and the Gold Coast, the two major producing countries.

Each of the major producing areas of the world (with the exception of Asia, for which little current information is available) has shown significant increases in production of cocoa in the past year. Central America has increased production 9% above 1953-54, but still remains 2% below 1952-53. South American production surpasses 1952-53 and 1953-54 by 46% and 25% respectively, while African production has increased 8% over the previous year, but remains 3% below 1952-53.

Most countries, especially Latin America, have reported better care of the cocoa trees through technological

advances. Extensive fertilisation of the plantation, thinning, pruning, selection and spraying of the trees and intensified efforts in agricultural research at the cocoa experimental stations and plant nurseries give promise of higher yields. There is reluctance to invest in increased plantings because of the long-term investment required before a return is realised. The chief deterrent to increased production and exports is the uncertainty of continued demand and thus a price permitting a profit.

Extensive work is being done in attempting to control the various diseases affecting cocoa production. Devastating results from swollen shoot still run rampant throughout the producing areas, especially in the Gold Coast, where a total of approximately 50,000 acres of cocoa (600 trees per acre) have been cut out and 11,000 acres replanted. Payments amounting to £3.4 million have been made to farmers for cutting out damaged trees and replanting since the grant scheme began in 1948. Effective methods of control of the black pod rot and capsid damage have been developed and plans for a control programme in the Gold Coast are now in a proposal stage. However, the acceptance by the African farmer of these new cultural methods will determine the degree of progress in improving quality and increasing yield per acre.

Foreign Crops and Markets.

MEDITERRANEAN AREA

Olive-oil. Mediterranean Basin olive-oil production from 1954-crop olives is forecast at 763,000 short tons on the basis of preliminary data available. This volume of oil would be only 60% of the very large out-turn of 1,256,100 tons estimated to have been produced from the 1953 olive crop. Moreover, this would be the smallest quantity of oil since four years ago, when production from the 1950 olive crop was an estimated 628,000 tons. These production estimates represent the total oil pressed, including allowances made for consumption by growers in countries reporting only commercial production.

A sharp decline from the 1953 level of production had been expected, with 1954 being an ' off ' year in the two-year cycle normally characteristic of olive production in the major producing countries. However, with unfavourable weather in some countries, especially Spain, production prospects were further adversely affected. On the other hand, in some countries where normal weather conditions prevailed oil production is expected to be above 1952, the previous ' off ' year.

The outstanding feature of this year's crop is the sharp reduction foreseen in Spain. The damage to trees resulting from the killing freeze of last February and the heavy snows in April appears to have been more extensive than originally estimated. Moreover, in a number of regions olive production was seriously affected by the prolonged drought from the end of April to the end of October. As a result, many trees had small, immature olives and there was heavy dropping as well as considerable shrivelling of olives. In addition, a large percentage of the fruit was severely damaged by insects.

Opinions vary widely regarding the volume of oil that can be expected from this season's crop in Spain. Nevertheless, it appears certain that with output tentatively estimated at 140,000 tons, and with a carry-over at the end of October estimated at 110,000 tons, the supply will fall far short of the normal domestic and export need. In this connection, the Spanish Government has announced that it is taking measures to import oils to assure adequate supplies.

Italy's olive-oil production is forecast at 220,000 tons. This tonnage would be less than 60% of the out-turn from the 1953 crop, but would be 10% above 1952, the previous year of low production. Weather in most areas was normal this season. In some regions, however, an excess of humid, hot days encouraged the spread of a fungus disease which causes the loss of foliage and fruit. The long-range trend in Italian olive-oil production is upward. According to one trade source, production of 440,000 tons of oil in a ' high ' year is a goal which may be reached within a few years.

Greece expects 125,000 tons of olive oil from the 1954 crop of olives, possibly one of the largest out-turns on record for an ' off ' year. Oil from the 1953 crop, placed at 174,600 tons, was the third largest on record. And in Portugal, if the forecast of 60,000 tons materialises, output will establish a new record for an ' off ' year. Over twice this volume—an all-time high—was produced from the 1953 crop of olives.

Production in the Middle East may approximate 75,000 tons, with Turkey accounting for possibly 60,000. Very little information is available as yet concerning other countries.

North African olive-oil production probably will be about 10% less than last season's output. Larger olive crops are anticipated in Algeria and French Morocco. And in Tunisia production is forecast at 65,000 tons. This reflects a decline of about one-quarter from last year, but appears to be the highest level of output in a year of low production.

ENGLAND AND WALES

Agricultural report. Agricultural conditions in England and Wales on February 1, 1955, have been summarised by the Ministry of Agriculture.

Weather conditions. The weather during January was changeable with heavy rain at times and widespread snowstorms. There were a few dry days at the beginning of the month, but these were followed by mainly wintry conditions which lasted until the end of the third week. The rest of the month was mainly dry and mild with one or two sunny days in most districts.

Cultivations and other field work. Apart from a little ploughing in some parts of the country at the beginning and the end of the month, conditions were unfavourable for cultivations. A little drilling was carried out on some light soils, but cultivations generally were very much behindhand. Progress was made with manure carting, hedging and ditching, but much of this work has been impeded.

Autumn-sown crops. Early-sown crops of wheat were satisfactory, but later sowings were slow to make growth. Some damage by waterlogging was reported and slugs were troublesome in several areas. Barley was generally healthy. Oats were generally satisfactory, although some later sowings were backward. Rye was a satisfactory crop. Beans were checked by frost in some districts, but generally crops were healthy.